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DAVIES (D. E.). **Seasonal Breeding and Migrations of the Desert Locust** (*Schistocerca gregaria* **Forskål) in north-eastern Africa and the Middle East.**—*Anti-Locust Mem.* no. 4, 56 pp., 13 maps (1 fldg.), 2 figs., 3 pp. refs. London, 1952.

This is the third of a series of papers on the seasonal breeding and migrations of *Schistocerca gregaria* (Forsk.) in different parts of its distribution area [*cf.* *R.A.E.*, A **36** 123, 206] and deals with Ethiopia north of 12°N. lat., Anglo-Egyptian Sudan north of 10°N. lat., Eritrea, Egypt, the Sinai Peninsula, Arabia, Jordan, Israel, Syria, the Lebanon, Iraq and south-eastern Turkey. It is based on the records of the Anti-Locust Research Centre for 1926–49, and also includes accounts of the physical features of the area, the seasonal distribution of the rainfall and the methods of analysis, which resembled those previously used. The following is largely the author's summary of the results.

Four breeding seasons can be distinguished in the area, namely, the monsoon, the winter and early spring, the main spring, and the pre-monsoon or seif. Monsoon-generation swarms migrate north-eastwards and northwards from the monsoon breeding belt in north-eastern Africa and southern Arabia, and some may breed on the Red Sea coasts of the Sudan, Eritrea and western Arabia, over a belt extending across Arabia, and in Trucial Oman. There is also a westerly migration from the central Sudan to French Equatorial and West Africa, in which swarms may join up with others produced there [**36** 206]. Swarms of the winter and early spring generation produced by the north-easterly and northerly migrants of the monsoon generation join in the northerly migration to northern Arabia and the Middle East [**36** 124]. A south-westerly deflection from the north-western part of the invaded area may result in the invasion of Egypt. Main spring breeding by swarms of these two generations gradually extends northwards through most of the invaded area, and some of the resultant main spring swarms, appearing in central and northern Arabia, may continue to move northwards through Iraq, Jordan and Israel. Further south, the major migrations of the main spring swarms are south-westwards and southwards towards the monsoon breeding belts in north-eastern Africa and southern Arabia ; the tendency to move southwards gradually spreads further northwards, and by June–July involves swarms that had earlier tended to move north. The early arrivals to the monsoon breeding belt may breed during rains preceding the onset of the south-west monsoon, and the resultant pre-monsoon swarms in north-eastern Africa and the seif swarms of south-western Arabia later take part, together with the main spring swarms, in monsoon breeding, which in some years may be sufficiently prolonged for the production of two successive monsoon generations.

The cycle is thus in many respects similar to that over most of western and north-western Africa [**36** 206], where four generations are possible during the year. It is theoretically possible for swarms migrating between north-eastern Africa and the Middle East to produce five generations a year, but it is not as yet known whether this number is ever in fact produced.

GUNN (D. L.) & HUNTER-JONES (P.). **Laboratory Experiments on Phase Differences in Locusts.**—*Anti-Locust Bull.* no. 12, pp. 1–29, 3 graphs, 31 refs. London, 1952.

DAVIES (D. E.). **Statistical Analysis of Data on the Selection Experiments.**—*T.c.* pp. 30–35, 2 graphs, 2 refs.

The experiments described in the first of these papers were carried out in cages with locusts from laboratory stocks kept under crowded conditions, in an attempt to reproduce the full range of phase variation in coloration and biometrics observed in the field. The following is substantially the authors' summary of the work.

Preliminary experiments with *Schistocerca gregaria* (Forsk.) confirmed the conclusions of earlier workers that when the hoppers are reared in isolation, they tend in the fifth instar to be chromatically unlike, and the adults to which they give rise biometrically like, sparsely occurring individuals of phase *solitaria* in nature, and that when crowded in cages the hoppers are chromatically like and the adults biometrically unlike swarm specimens of phase *gregaria* [*cf. R.A.E.*, A **20** 671 ; **34** 350]. Preliminary experiments with *Locusta migratoria migratorioides* (R. & F.) resulted in chromatically satisfactory hoppers of both phases, but the biometric ratios (E/F) of the adults that had been reared under crowded conditions were much lower than those of field *gregaria*. *Locusta* hoppers that were isolated after being crowded acquired the chromatic characters of phase *solitaria* in one or two instars, but the adult biometrics were affected progressively throughout growth by the duration of isolation of the hoppers. When *Locusta* hoppers were reared either in moist air with fresh food or in dry air with food that was allowed to dry up, they differed only slightly and uncertainly in adult E/F ratio, but the differences that were found usually indicated a correlation between higher E/F ratios and drier conditions. When *Locusta* was reared under crowded conditions in a freely ventilated cage that became cold at night, the E/F ratios of the adults were substantially higher than those of locusts reared in less ventilated cages with thermostatic control. In four generations of selection, two distinct lines were separated from a parental group of locusts. The selection was made mainly for high E/F ratio on the one hand and low E/F ratio on the other, and the difference between the averages for the resulting lines was as great as the differences produced by isolation or crowding. This selection did not reduce variability and was not accompanied by a corresponding change in other characters used in biometric estimates of phase status. Selection did not reduce the susceptibility of either strain to change in E/F ratio by crowding or isolation. In addition to such inherited influences on characters used in estimating phase status, there may be inheritance of another sort. The colour of freshly hatched hoppers and marching behaviour of hoppers appear to depend on the degree of crowding of their parents [*cf.* **39** 190].

The second paper contains statistical analyses of the data obtained in the selective breeding experiments described in the first.

KAESER (W.). **Zur Frage einer temperaturbedingten Widerstandsfähigkeit der Honigbiene (*Apis mellifica* L.) gegenüber dem Kontaktinsektizid DDT (Gesarol).** [On the Question of the Dependence on Temperature of Resistance in the Honey Bee to the Contact Insecticide DDT.]—*Anz. Schädlingsk.* **21** pt. 9 pp. 129–132, 2 graphs, 10 refs. Berlin, 1948.

Since it was not clear from experiments by Häfliger on the contact toxicity of DDT to honey bees [*cf. R.A.E.*, A **38** 248] whether the decrease in mortality with increase in temperature from 20°C. [68°F.] to 36°C. [96·8°F.] (hive temperature) was due to increasing resistance in the bees or to decreasing toxicity of the DDT, further tests were carried out in July–August 1948. Bees from a single colony were placed in darkened ventilated cages with solutions of honey and sugar for food at temperatures of 22, 35 or 40°C. [71·6, 95 or 104°F.] and 70–90 per cent. relative humidity. In the first series, the cages were lined with paper that had been sprayed three days previously with a proprietary DDT suspension, and in the second the bees themselves were sprayed with the same material before being put in the cages, which were lined in this case with untreated paper. In the first series, the bees kept at 22 and 40°C. all died within 36 hours and four days, respectively, as compared with 21 and 15 per cent. mortality in ten days in the controls, whereas of those kept at 35°C., 12 per cent. died in 24 hours and the others were still normal on the tenth day. Among the controls kept at 35°C., mortality did not occur until

the eighth day and reached 9 per cent. by the tenth. In the second series, the results at 22 and 40°C. were the same as for the first, but mortality at 35°C. was no greater than for the controls. It is concluded that it is the susceptibility of the bees that varies, and not the toxicity of DDT.

DOSSE (G.). **Der Grosse Kohltriebrüssler** *Ceuthorrhynchus napi* **(Gyll.): Biologie, Schadauftreten und Bekämpfung under besonderer Berücksichtigung der "Gallbildung" an Kohlpflanzen.** [The Large Cabbage Shoot Weevil: Biology, Occurrence as a Pest and Control, with special Reference to "Gall Formation" on Cabbage.]—*Z. angew. Ent.* **32** pt. 4 pp. 489–566, 41 figs., 65 refs. Berlin, 1951.

Ceuthorrhynchus napi Gylh. is widely distributed in southern and south-western Germany and causes serious injury to rape, turnip rape and varieties of cabbage [*cf. R.A.E.*, A **30** 538]. All stages of this weevil are described, and an account is given of investigations on its bionomics and control at Hohenheim, near Stuttgart, in 1946–49, when an outbreak that began during the war years appeared to be declining. The overwintered adults were observed in March, the date depending on temperature and rainfall, though an exact relation could not be established. The females appeared about a week before the males, and both sexes caused superficial damage to the plants, which was not of economic importance. The period between emergence from hibernation and oviposition ranged from nine days to almost three weeks, depending on weather. Eggs were laid in the plant tissue near the growing shoot of rape or cabbage, and the processes of pairing and oviposition are described. The average number of eggs laid per female in the laboratory was 11 and the maximum 14, but it is thought that these numbers would be exceeded under field conditions. The larvae hatched in 8–16 days in early spring and bored in the stalks, reaching the heart region in the case of young cabbage. They fed for 32–47 days early in the season and left the plants in April or May, when they entered the soil and formed earthen cocoons in which to pupate. They entered the pupal stage about three weeks after leaving the plants, and the resulting adults remained in the cocoons until the following spring. Development was accelerated at higher temperatures. The chief natural enemies were species of *Thersilochus* [*cf.* **30** 539], which parasitised a high percentage of the larvae in the soil.

The damage caused to different food-plants is described in detail, and it is shown that oviposition is often followed by necrosis before the larvae hatch, resulting in malformation and the death of young plants. Attempts to produce these symptoms by mechanical means in the laboratory failed, and it is assumed that they were caused by a secretion from the eggs.

The experiments on control in 1946–47 have already been noticed [**39** 230]. Further work against the overwintered adults was carried out with E 605 Staub [a dust of 2 per cent. methyl-parathion*] and E 605 forte [a spray concentrate consisting of 50 per cent. parathion and 50 per cent. emulsifier*]. In

* We are indebted to Dr. G. Schrader for the following information, sent in October 1952, on the composition of these and other preparations containing parathion (O, O-diethyl O-p-nitrophenyl thiophosphate), methyl-parathion (O, O-dimethyl O-p-nitrophenyl thiophosphate) or both. It clarifies an earlier foot-note [*R.A.E.*, A **40** 45], which was based on the information available at the time. E 605 was the name coined for parathion and is used for it in the scientific literature, but as it was not desired to introduce a special name for methyl-parathion in commercial preparations such as E 605 f 3, the active ingredients of these are defined on the containers on a basis of alkylthiophosphoric acid ester. E 605 f was a preparation consisting of 70 per cent. parathion (E 605) and 30 per cent. emulsifier. E 605 forte consists of 50 per cent. parathion (E 605) and 50 per cent. emulsifier. E 605 f 3 comprises 35 per cent. of a 20 : 80 mixture of parathion (E 605) and methyl-parathion and 65 per cent. emulsifier. E 605 Staub is a dust consisting of 2 per cent. methyl-parathion and 98 per cent. inert material.

E 605 Staub was the dust cited as parathion dust in a previous abstract [**39** 231] and mentioned with the authors' definitions in subsequent ones [**40** 45, 46, 132].—*Ed.*

1948, the dust was applied at 18 lb. per acre at the end of March and again 13 days later and gave good control, the increases in yield ranging up to 26·1 per cent. for rape and 51·3 per cent. for turnip rape, as compared with no treatment. In 1949, when infestation was less severe, dusting on 5th and 14th April gave good results, and the spray, which was applied twice at a concentration of 0·05 per cent. E. 605 forte on 1st and 11th April, was about as effective as the dust.

The success of treatment against the adults depends on correct timing, and as it was impossible to forecast the exact date of emergence, tests were carried out against the eggs and larvae with a proprietary spray of benzene hexachloride (Nexen). This gave complete mortality when applied to rape twice at suitable concentrations in 1948 and 1949, no larvae developing beyond the first instar, but treatment had to be completed early if the plants were to be protected from the pathological changes resulting from the presence of eggs.

EICHLER (W.) & SCHRÖDTER (H.). **Witterungsfaktoren als Urheber der Massenvermehrung des Rübenderbrüsslers** (*Bothynoderes punctiventris*) **1947-1949 in Mitteldeutschland.** [Climatic Factors as Causes of the Outbreak of *Cleonus punctiventris* in Central Germany in 1947–49.]—*Z. angew. Ent.* **32** pt. 4 pp. 567–575, 2 graphs, 14 refs. Berlin, 1951.

Cleonus (*Bothynoderes*) *punctiventris* (Germ.) is a serious pest of sugar-beet in south-eastern Europe and Turkey. The adults feed on the leaves in spring and the larvae on the roots in June–July. The weevil is also present in central Germany but is normally of no importance there. A minor outbreak was reported, however, in 1935, and an increase in population in 1947 was followed by serious damage in Sachsen-Anhalt in 1948. The extent of injury is determined by the numbers of the pest and the rapidity of growth of the crop. These two factors are ultimately dependent upon meteorological conditions [*cf.* *R.A.E.*, A **25** 52]. Warm, dry weather in the summer of 1947 favoured the development of the pest, and similar conditions in April 1948 led to early emergence from hibernation and reduced the rate of growth of the beet. Numbers were reduced in 1949, and examination of the meteorological records for that year showed that there was little likelihood of further serious injury in 1950.

VON LENGERKEN (H.). **Zur Brutbiologie des Pappelblattrollers** (*Byctiscus populi* **L.**). [Note on the Breeding Habits of *B. populi*.]—*Z. angew. Ent.* **32** pt. 4 pp. 599–603, 6 figs. Berlin, 1951.

From observations near Potsdam, the author describes the process by which females of *Byctiscus populi* (L.) roll the leaves of aspen (*Populus tremula*) on which they have oviposited. One egg was laid on each leaf, and a single female rolled 11 leaves in three days in May 1948. An incision is made just below the leaf, which causes it to wither and become suitable for feeding by the larva.

HERING (E. M.). **Ein neuer Getreideschädling** *Agromyza veris* **sp. nov. (Dipt.).** [A new Pest of Cereals, *A. veris*, sp. n.]—*Z. angew. Ent.* **32** pt. 4 pp. 604–608, 3 figs. Berlin, 1951.

Characters distinguishing *Agromyza veris*, sp. n., from two related species are described, Hendel's key is amended to include it, and notes are given on the larval mines and the morphology of the puparium. The species was reared from rye, barley, wheat and wild grasses near Berlin. It has one

generation a year, and the larvae are present from mid-April to mid-May. Its occurrence so early in the year makes it of potential economic importance as a pest of cereals.

SCHRADER (G.). **Die Entwicklung neuer Insektizide auf Grundlage organischer Fluor- und Phosphor-Verbindungen.** [The Development of new Insecticides on the Basis of organic Fluorine and Phosphorus Compounds.]—*Monogr. angew. Chem. & Chem.-Ing.-Tech.* no. 62, 2nd edn., 96 pp., 4 graphs, 10 pp. refs. Weinheim/Bergstr., Verlag Chemie, 1952. Price *DM.* 8.50.

The author gives an account in this booklet of the investigations in Germany of which he has been in charge since 1934 on the development of new synthetic insecticides for use on plants and plant products. The work began with an investigation of organic fluorides, and the fumigant effect on insects of methane sulphonyl fluoride was soon discovered. This substance resembled hydrocyanic acid gas in toxicity, but it was abandoned on account of high absorption and retention by grain and other foodstuffs. Modification of the molecule led only to decreased toxicity. Derivatives of β-fluoro-ethanol also showed insecticidal properties, but the parent alcohol was difficult to prepare on a technical scale and both it and the derivatives were very toxic to warm-blooded animals. Methylals of the alcohol gave high mortality of *Phylloxera vitifoliae* (Fitch) on the roots of grape vines when applied as a spray to the leaves, which absorbed the toxic ingredient. The latter is retained in plants for 3-4 weeks and renders them highly toxic to man. Oxidation of β-fluoro-ethanol results in fluoroacetic acid, and though neither this nor esters of it showed pronounced insecticidal properties, the acid has recently been isolated in South Africa from the plant gifblaar (*Dichapetalum cymosum*), extracts from which have been stated to be toxic to insects. Methods of preparing the acid are reviewed.

Attention was directed in 1936 to organic phosphorus compounds, and simple esters and ester-amides of phosphoric and thiophosphoric acid were investigated. Substitution of ester-amides of phosphoric acid with acid substituents showed promise, and certain alkylamino and dialkylamino esters and diamides of fluorophosphoric acid proved toxic to insects, though unsuitable for practical use. One of the diamides, the di-dimethylamide of fluorophosphoric acid [bisdimethylamino fluorophosphine oxide], was taken up systemically by plants from aqueous sprays, but is highly toxic to man.

Esters of fluorophosphoric acid were further studied, and the diethyl ester was found to possess a powerful contact and fumigant effect, though it was too toxic to warm-blooded animals for use. A similar study of the esters of pyrophosphoric acid led to the discovery in 1938 of the toxicity of TEPP (tetraethyl pyrophosphate), but recognition in 1939 of its outstanding properties as a contact insecticide caused it to be held as an official military secret, so that no commercial use could be made of it until after the war. Its properties and preparation are reviewed. Since TEPP showed poor stability in water, derivatives of it were tested. Substitution of dimethylamino groups improved stability, but the incorporation of one decreased toxicity, two rendered the compound highly phytotoxic, and three and four (the last resulting in the systemic insecticide known as schradan (octamethyl pyrophosphoramide)) rendered it phytotoxic in some cases. The properties of schradan are reviewed from the literature. Substitution of diethylamino groups in TEPP depressed toxicity.

Further investigation of polyphosphate esters led in 1940 to the production of HETP (hexaethyl tetraphosphate), known in Germany as Bladan. This proved to be a complete substitute for nicotine against Aphids, etc., but was held an official secret until 1944. Its preparation, properties and composition

[*cf. R.A.E.*, A **37** 487] are reviewed. Since both HETP and TEPP (one of its constituents) were very unstable in water, a Bladan that would be resistant to hydrolysis and if possible to lime was sought. Replacement of one of the double-bonded oxygen atoms in TEPP by sulphur led to tetraethyl monothiopyrophosphate. This proved more resistant to hydrolysis than TEPP, was fairly stable in water at room temperature at pH values of 4–7, but was unstable at pH 7–9. It showed rapid toxicity to insects of many different species and a practical method of preparation was evolved, but its excessive toxicity to warm-blooded animals prevented its commercial development. When the other double-bonded oxygen atom was also replaced by sulphur, the resulting tetraethyl dithiopyrophosphate (E 393) proved completely resistant to hydrolysis, largely resistant to alkali, extremely toxic to insects and not highly toxic to warm-blooded animals. Methods of preparation were developed, and practical tests in 1944 showed it to be highly toxic to spider mites and mosquito larvae. It is used as a fumigant under the name Bladafum against spider mites in greenhouses.

Further investigation of organic esters of phosphoric and thiophosphoric acids resulted in the discovery of a new group of insecticidal materials. These included paraoxon (diethyl p-nitrophenyl phosphate), referred to as E 600 or Mintacol, and parathion (O,O-diethyl O-p-nitrophenyl thiophosphate), referred to as E 605 or Thiophos. Paraoxon proved effective against a wide range of insects in field tests in 1944 and 1945, but was found to be highly toxic to laboratory animals and to penetrate the human skin. It was therefore not suitable for further commercial development as an insecticide. Parathion was prepared in the second half of 1944 and showed itself to be a very powerful contact insecticide and also a stomach poison and fumigant and to be less dangerous than paraoxon. Its preparation and physical and chemical properties and methods of analytical determination are described and its toxicology reviewed. Studies on it showed that the corresponding o- and m-nitrophenyl compounds were much less effective, that when the ethyl groups were replaced by methyl groups the resulting methyl-parathion (referred to as 18/120) was as toxic to insects but less so to warm-blooded animals, and that when the nitro-group was eliminated or replaced by chlorine or other acid substituents, insecticidal efficiency became negligible. Replacement of the alkoxyl groups by dialkylamino groups also reduced toxicity.

Although parathion proved highly toxic to many insects and mites, it was unsatisfactory against the potato beetle [*Leptinotarsa decemlineata* (Say)], and a modification of it that would control that pest was therefore sought. Replacement of the phenyl radicle by various hydroxyheterocyclic compounds resulted in the preparation of the O,O-diethyl thiophosphoric acid ester of 7-hydroxy-4-methyl coumarin, referred to as E 838 or Potasan. This material, the physical properties of which are described, is mainly a stomach poison, with only secondary fumigant or contact effect, and is soluble in lipoids. It was very toxic to adults and larvae of *L. decemlineata*, a 2 per cent. dust applied to potatoes at about 9 lb. per acre being effective, but much less so to Aphids, caterpillars or ants. Its toxicity was due to the phosphorus component, corresponding phosphorus-free derivatives being found ineffective.

The next group to be studied comprised compounds obtained by replacing one hydrogen atom in triethyl phosphate or thiophosphate by a halogen. Their insecticidal value was small, but some indication was obtained in further work that phosphates of glycol ethers or glycol thioethers were more promising. Phosphoric and thiophosphoric acid esters of ethylene glycol ethers proved disappointing, but investigation of the corresponding thioethers led to a group of compounds of notable insecticidal properties, particularly the thiophosphoric acid esters. The best was O-(2-(ethylmercapto)ethyl) O,O-diethyl thiophosphate, referred to as E 1059 and given the trade designation of Systox.

It is a better systemic poison than any other known phosphorus compound, and will protect treated plants for four weeks against sucking insects. It has little effect on chewing insects when applied as a spray to plants, and vaporises rapidly from plant surfaces. Its preparation, physical properties and translocation in plants are reviewed. It is absorbed through roots, leaves and young growing plant parts and is retained for 3–4 weeks. It is particularly adapted for the control of Aphids and red spider mites, and its selective action renders it harmless to natural enemies. It is about as toxic to warm-blooded animals as parathion, though there is somewhat less danger from sprays and somewhat more from absorption through the skin.

Systox showed the same tendency as parathion to isomerise by exchanging the double-bonded sulphur on the phosphorus atom for double-bonded oxygen at high temperatures. This results in an ester of still greater systemic effect differing little from Systox in physical properties or toxicity to insects but more soluble in water. It is referred to as isomeric Systox, and methods of preparing it were investigated, but it was found to be more toxic to animals than Systox and was therefore not introduced commercially.

The latest group to be studied comprised organic compounds of phosphorus and selenium, and some promise was shown by selenium compounds analogous to Systox, but they had an unpleasant odour, were expensive to produce, on account of the selenium, and highly toxic to warm-blooded animals. Several esters of seleno-phosphoric acid possessed systemic properties and were toxic to insects.

A note is appended by Kuppe on the determination of parathion and methyl-parathion.

HENNIG (W.). **Die Larvenformen der Dipteren. Eine Übersicht über die bisher bekannten Jugendstadien der zweiflügeligen Insekten. 3. Teil.** [Larval Forms in Diptera. A Review of the known immature Stages of Dipterous Insects. Part 3.]—vii + 628 pp., 21 pls., 338 figs., 100 pp. refs. Berlin, Akademie-Verlag, 1952. Price *DM.* 65.

The third and largest part of this work [*cf.* *R.A.E.*, A **38** 227] is devoted to the Brachycera, which are treated in the same way as were the Nematocera. The bibliography covers the whole of the Diptera, and an index to the genera in all three parts is appended.

EVANS (J. W.). **The injurious Insects of the British Commonwealth (except the British Isles, India and Pakistan), with a Section on the Control of Weeds by Insects.**—10 × 7 ins., vii + 242 pp., frontis. London, Commonw. Inst. Ent., 1952. Price 30*s*.

In this reference book, the author summarises available information on the arthropod pests that attack agricultural crops, horticultural plants and forest trees in the various countries of the British Commonwealth, except the British Isles, India and Pakistan, which present entomological problems of a different order, and its subject matter is drawn primarily from the first 38 volumes of this *Review*. The introductory part (pp. 1–37) gives for each country for which entomological information is available brief outlines of its physical features, climate and main crops, a list of the principal pests of plants and another of comprehensive publications dealing with them, and general information on the insects and other arthropods that affect the health of man and stock. The second part (pp. 38–58) consists of a list of agricultural crops showing their more important pests and the countries in which these are recorded as injurious. The third and main part (pp. 59–203) comprises an

annotated list of some 1,100 injurious insects and mites. They are arranged alphabetically under the families or orders, and the notes, which are usually more detailed for the more important species, show synonymy or earlier misidentifications, and provide concise information on Commonwealth distribution, the plants attacked, the nature and extent of the damage caused, and in many cases bionomics and methods of control (excluding chemical methods) that have been adopted, with frequent references to Series A of the *Review*. The two remaining parts comprise brief accounts of work on the control of noxious weeds by means of insects (pp. 204–210) and notes on special subjects (pp. 211–221), including the spread of insects and plant quarantine, the conditions that enable insects to become pests, the different methods of controlling insects, and lines along which further work is desirable, together with a list of insect vectors of virus diseases showing the plants affected.

REYNOLDS (H. T.), ANDERSON (L. D.) & SWIFT (J. E.). **Acaricide Dusts on Vegetable and Field Crops in southern California, 1949–50**—*J. econ. Ent.* **45** no. 3 pp. 359–365, 2 refs. Menasha, Wis., 1952.

The following is based on the authors' summary. The most important of the mites that attack vegetable and field crops in southern California are *Tetranychus bimaculatus* Harvey, *T. multisetis* McG. and *T. atlanticus* McG., and various dusts applied with rotary hand dusters were tested during 1949 and 1950 against *T. multisetis* on snap (pole) beans, lima beans and watermelon, *T. bimaculatus* on watermelon and red clover and *T. atlanticus* on lucerne and cantaloupe melons.

Aramite (2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite) gave excellent initial control of all three, had good persistent effect and was outstandingly better than the other materials tested against *T. bimaculatus*. A 2 per cent. impregnated dust was much better than a 5 per cent. dust prepared from wettable powder, but a 1 per cent. impregnated dust gave poor results. Ovotran (p-chlorophenyl p-chlorobenzenesulphonate) in a 10 per cent. dust gave a low initial kill but showed persistent effect and was best used as a preventive dust. It gave excellent control of *T. atlanticus* and *T. multisetis*, but was somewhat inferior to Aramite against *T. bimaculatus*. Sulphenone (p-chlorophenyl phenyl sulphone) in a 10 per cent. dust gave only fairly good control of *T. bimaculatus* and *T. multisetis*, but was excellent against *T. atlanticus* at the high temperatures of the inland and desert areas. Control with 10 per cent. 2,4-dichlorophenyl benzenesulphonate (Compound 923) was inconsistent. It was excellent against *T. atlanticus* in hot desert areas, fair against *T. multisetis* and poor against *T. bimaculatus*.

In general, all the phosphates tested gave good initial reductions, but had little persistent effect, necessitating two applications, the second timed to kill mites hatching from eggs that were present at the time of the first application, but EPN (O-ethyl O-p-nitrophenyl benzenethiophosphonate) was relatively ineffective. When O,O-dimethyl S-(2-oxo-2-ureidoethyl) dithiophosphate and S-carbamylmethyl O,O-dimethyl dithiophosphate were tested against *T. multisetis*, the initial reduction was good, but control was poor 16 days later. Two applications three weeks apart of 5 per cent. malathon (S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate) or 1 or 2 per cent. parathion gave good control of *T. multisetis* in relatively cool coastal areas; two of 1 or 2 per cent. parathion, 19 days apart, gave poor control of a mixed population of *T. multisetis* and *T. bimaculatus* at moderate temperatures, but two of 1 per cent. parathion, 14 days apart, gave good control of *T. atlanticus* in the hot desert areas. Two applications of 1 per cent. tetraethyl pyrophosphate also gave good control of *T. atlanticus* in the desert.

Sulphur gave almost complete control of *T. atlanticus* in the hot inland areas, but only fair control of *T. multisetis* in cooler ones. Karathane (dinitrocaprylphenylcrotonate) at 3·5 per cent. and 2,3,3a,4,5,6,7,7a,8,8-decachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene-1-one at 5 per cent. gave poor control of *T. multisetis*, and a dust of 2·5 per cent. DMC (4,4′-dichloro-α-methyl benzhydrol [also known as 1,1-bis (p-chlorophenyl)ethanol]) blended from wettable powder gave only fair control.

T. atlanticus appeared to be the most and *T. bimaculatus* the least susceptible of the three mites to the control measures tested. In flavour tests on snap beans dusted twice with Sulphenone, malathon, Ovotran, Compound 923, Aramite or parathion, picked 15 or 34 days later and cooked, only beans treated with Compound 923 were significantly affected after 15 days and none after 34. At high desert temperatures (100°F. or more), Sulphenone, Compound 923, Ovotran and Aramite caused slight injury to the vines of cantaloupes, but subsequent observations indicated that they cause no injury when applied uniformly by powder dusters or from aeroplanes.

MICHELBACHER (A. E.), MIDDLEKAUFF (W. W.) & BACON (O. G.). **Mites on Melons in northern California.**—*J. econ. Ent.* **45** no. 3 pp. 365–370, 2 refs. Menasha, Wis., 1952.

The application of DDT to melons in northern California for the control of the Galerucids, *Diabrotica undecimpunctata* Mannh. and *Acalymma trivittata* (Mannh.), or the Jassid, *Empoasca abrupta* DeL., sometimes results in increases of *Aphis gossypii* Glov. [*cf. R.A.E.*, A **39** 109] and mites of the genus *Tetranychus*, of which the most injurious is *T. pacificus* McG. Other chlorinated hydrocarbons have the same effect with regard to the mites, as was shown in tests on honeydew melons in 1951, when dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and heptachlor [1(or 3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene] at 0·75 and 1 lb. per acre, respectively, in concentrated sprays and 2·5 per cent. aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], 3 per cent. heptachlor and 5 per cent. Q-137 [ethyl-DDD (1,1-bis(p-ethylphenyl)-2,2-dichloroethane)] in dusts used at 20–30 lb. per acre, all applied twice on 9th and 25th July, resulted in greater numbers of infested leaves than no treatment. This increase did not occur when 3 per cent. DDT was applied with 50 per cent. sulphur, but sulphur is injurious to most varieties of melon other than honeydew. Counts of mites on samples of treated leaves from another test confirmed that the population increased more rapidly following treatment with dieldrin and aldrin at 0·5 and 1 lb. per acre, respectively, in concentrated sprays than after a dust of DDT and sulphur.

Outbreaks of the mites also occasionally occur in the absence of DDT. They can be largely avoided by the precautions recommended against the Aphid [*loc. cit.*]. Both pests can be controlled by dusts of 1 per cent. tetraethyl pyrophosphate or 2 per cent. parathion under favourable conditions, and tests with two further acaricides, Aramite [2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite] and Ovotran (p-chlorophenyl p-chlorobenzenesulphonate), in dusts against the mites were carried out. In 1950, 3 per cent. Aramite at about 30 lb. per acre gave satisfactory control of several outbreaks and maintained it for at least three weeks in one typical case. In 1951, when tests were made in various districts, 10 per cent. Ovotran and 3 per cent. Aramite at 30 lb. per acre were very effective on honeydew melon in August, Ovotran proving slightly the better, and both were successfully used with 3 per cent. DDT. Mixtures of this type could be used when the Galerucids or the Jassid are numerous as well as the mites. In other tests with Aramite, a 3 per cent.

dust gave satisfactory mite control at only 16·5 lb. per acre when coverage was good, and 1 lb. Aramite per acre in a concentrated emulsion spray prepared from a concentrate containing 2 lb. Aramite per U.S. gallon was highly satisfactory.

Some control of the mites is afforded by predators, of which the more important include *Orius tristicolor* (White), *Scolothrips sexmaculatus* (Perg.), *Stethorus* sp. and Laelaptid mites.

In the early spring of 1950, germinating cantaloupes at one place in the central San Joaquin Valley were injured by the Tetranychid, *Petrobia latens* (Müller) [*cf.* **40** 72]. Parathion proved effective for control.

Shen Chin Chang. **The Speed of toxic Action on the Pea Aphid of several Insecticides.**—*J. econ. Ent.* **45** no. 3 pp. 370–372, 1 graph, 7 refs. Menasha, Wis., 1952.

Since *Macrosiphum pisum* (Harris) (*pisi* (Kalt.)) is a serious pest of leguminous crops in Oregon and transmits several viruses of peas and beans, various organic insecticides or insecticidal mixtures were tested against it in a dust tower in 1948–50. When applied at a dosage equal to 43 lb. per acre, 1 per cent. parathion, 5 per cent. DDT, with or without 10 per cent. sulphur, 1 per cent. γ BHC (benzene hexachloride), 5 per cent. rotenone with 10 per cent. other cubé extractives, 0·18 per cent. TEPP (tetraethyl pyrophosphate), 1 or 3 per cent. nicotine and a test material (CPR-20-RS) containing 0·05 per cent. pyrethrins, 0·5 per cent. technical piperonyl cyclonene, 0·25 per cent. rotenone, 0·5 per cent. other cubé resins and 25 per cent. sulphur all gave 50 per cent. mortality in about an hour or less and 90 per cent. in less than two hours; 10 per cent. methoxy-DDT (methoxychlor), 5 per cent. DDD (TDE) [dichlorodiphenyl dichloroethane], Pyro-cel (a proprietary product containing rotenone, pyrethrins and a synergist), 1 per cent. aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,-5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] or dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and 0·86 per cent. EPN [O-ethyl O-p-nitrophenyl benzenethiophosphonate] were progressively slower in action, and 5 per cent. chlordan and toxaphene were not much more effective than talc alone.

When the insecticides were classified as producing symptoms of excitement and hyperactivity or having an anaesthetising effect, it was found that those in the first group, which included nicotine, BHC, parathion and TEPP, were usually, but not always, more rapid in killing action than those in the second, which included rotenone, CPR-20-RS, Pyro-cel, DDT, methoxy-DDT, DDD, chlordan, toxaphene, aldrin, dieldrin and EPN. However, speed of toxic action and the ability to produce hyperexcitability were evidently independent characteristics, as 5 per cent. DDT and 1 per cent. parathion gave 50 per cent. kill in 57 and 68 minutes, respectively. It was also observed that closely related chemicals did not kill the Aphids at similar speeds of action. As 1 and 3 per cent. nicotine gave 50 per cent. kill in 15 and 12 minutes, respectively, this seems to be the most dependable insecticide under favourable weather conditions. TEPP was the most rapid of the organic phosphates and leaves no residue. None of the materials tested seemed to inhibit reproduction, and many Aphids not killed within an hour produced offspring.

Neiswander (R. B.). **Control of Mites on woody ornamental Plants.**—*J. econ. Ent.* **45** no. 3 pp. 373–376, 2 refs. Menasha, Wis., 1952.

Paratetranychus ununguis (Jac.) has recently increased in importance on arbor vitae [*Thuja*], spruce and juniper (*Juniperus* spp.) in Ohio. In tests against it in 1949, Ovotran (p-chlorophenyl p-chlorobenzenesulphonate) was

very effective and the best of several acaricides tried. In 1951, acaricides were applied to juniper in a nursery on 3rd August, when the mite had already discoloured the plants. All were effective and would probably give satisfactory control if applied twice at an interval of about five days, but sprays of 1 lb. 50 per cent. Ovotran, 1 U.S. pint Systox (32·1 per cent. trialkyl thiophosphate [O-(2-(ethylmercapto)ethyl) O,O-diethyl thiophosphate]) and 1 U.S. pint Metacide (6·2 per cent. parathion and 24·5 per cent. methyl-parathion) per 100 U.S. gals. and a dust of 5 per cent. Ovotran were superior to sprays of 1 lb. 25 per cent. S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate [malathon], 4 oz. 25 per cent. EPN (O-ethyl O-p-nitrophenyl benzenethiophosphonate), 8 oz. 15 per cent. parathion, 1 lb. 25 per cent. Compound 923 (2,4-dichlorophenyl benzenesulphonate) or 1 lb. 15 per cent. Aramite [2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite] or dusts of 5 per cent. malathon, 10 per cent. Compound 923 or 5 per cent. Aramite. The dusts were applied again on 10th August, with similar results, but observations seven weeks after application showed that the mite had increased considerably on all plots but those receiving Ovotran. The sprays were applied again, in some cases at increased concentrations, on 15th August, when Ovotran at 1 lb. actual compound per 100 U.S. gals. and Systox gave outstanding control, and were better than any other treatment. Further tests were carried out on young Norway spruce (*Picea abies*), which was sprayed on 17th September with 2 lb. 50 per cent. Ovotran, 3 lb. 25 per cent. Compound 923 or 3 lb. 25 per cent. malathon per 100 U.S. gals. All gave good control, the first being the least rapid in action and the second the least persistent. A single application at 30-35 lb. per acre of a dust consisting of 1 part 50 per cent. Ovotran, 1 part talc, 1 part gypsum and 2 parts sulphur by aeroplane to mixed plants in a nursery on 22nd May caused 94·1 per cent. mortality of the mite on arborvitae two days after treatment, when 37 living examples per 100 twigs were found. This number fell to nine on 31st May and 0 on 20th June. The mite reappeared on arborvitae in October and was then also present on juniper in the dusted area, but injury was negligible.

Azalea plants 12 ins. high that were severely damaged by *Tarsonemus pallidus* Banks and *Vasates atlantazaleae* (Keifer) were treated on 10th August with the dusts tested against *P. ununguis*. Compound 923 gave the best control of *T. pallidus*, and malathon was the only one effective against *V. atlantazaleae*.

Matthysse (J. G.) & Naegele (J. A.). **Control of several Tree and Shrub Leaf Miners.**—*J. econ. Ent.* **45** no. 3 pp. 377–383, 12 refs. Menasha, Wis., 1952.

The following is based on the authors' summary. The results are given of investigations in New York State in 1948–51 in which birch, elm, holly, boxwood (*Buxus* spp.) and arborvitae (*Thuja* spp.) were sprayed with several of the newer insecticides to determine their effectiveness against larvae mining within the leaves, and comparisons were made with treatments applied against the ovipositing adults. All spray quantities are per 100 U.S. gals. water.

Sprays of 5 lb. 40 per cent. wettable chlordan, 1 lb. 25 per cent. wettable lindane [at least 99 per cent. γ benzene hexachloride], 0·5 U.S. pint 50 per cent. emulsifiable Systox [O-(2-(ethylmercapto)ethyl) O,O-diethyl thiophosphate] were very effective against larvae of *Fenusa pusilla* (Lep.) on birch if applied as soon as the mines appeared. Control of the first generation only was insufficient to maintain good tree appearance in small plantings. Sprays of 4 lb. 40 per cent. wettable chlordan or 1 U.S. pint 50 per cent. emulsifiable Systox and the lindane spray were very effective against *F. ulmi* Sund. on elm when applied at the same time as on birch, and control of the first-generation larvae was

sufficient to maintain good tree appearance throughout the season. Lindane is considered to be the most practical insecticide against these two species.

None of the insecticides tested was effective against larvae of *Phytomyza ilicicola* Lw. (*ilicis*, auct.) on American holly (*Ilex opaca*) ; 3 lb. 50 per cent. wettable DDT gave incomplete protection when applied against the adults and resulted in an increase in *Paratetranychus ilicis* (McG.).

One application of 1·5 lb. 15 per cent. wettable parathion gave complete control of larvae of *Monarthropalpus buxi* (Lab.) on boxwood, whereas parathion at lower concentrations and the other insecticides tested did not. DDT at 3–4 lb. 50 per cent. wettable powder or 1 U.S. quart 25 per cent. emulsion concentrate gave very good though not complete control of the adults, but resulted in increased damage by *Simplinychus* (*Neotetranychus*) *buxi* (Garm.). One application of 2 lb. 15 per cent. wettable parathion was very effective against larvae of *Argyresthia thuiella* (Pack.) on arborvitae, all the other materials tested being useless. A spray of 2 lb. 50 per cent. wettable DDT gave very good control of adults and reduced the numbers of larval mines but caused greatly increased injury by *P. ununguis* (Jac.), even when an acaricide was included.

MATTHYSSE (J. G.) & NAEGELE (J. A.). **Spruce Mite and Southern Red Mite Control Experiments.**—*J. econ. Ent.* **45** no. 3 pp. 383–387, 1 ref. Menasha, Wis., 1952.

In 1948–51, single applications of various sprays were tested for the control of *Paratetranychus ilicis* (McG.) on azalea and American holly [*Ilex opaca*] and *P. ununguis* (Jac.) on Norway spruce [*Picea abies*] in New York State. Mortality and populations were recorded for at least six weeks after treatment. All spray quantities are given per 100 U.S. gals. High mortality within one day of motile mites of both species was given by 1 U.S. pint emulsion concentrate containing 25 per cent. 1,1-bis(p-chlorophenyl)ethanol [DMC] or 50 per cent. Systox [O-(2-(ethylmercapto)ethyl) O,O-diethyl thiophosphate] and by 1–2 lb. 15 per cent. wettable Aramite (2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite). Emulsion sprays of 0·15 lb. Aramite or 9·5 fl. oz. 25 per cent. parathion and wettable-powder sprays of 0·5 lb. 25 per cent. EPN [O-ethyl O-p-nitrophenyl benzenethiophosphonate] or 0·6 lb. 40 per cent. DMC also gave high kills of *P. ilicis*. A selenium concentrate (1·03 per cent. selenium as potassium ammonium selenosulphide) at 1–2 U.S. quarts gave rapid kills of *P. ununguis* but not of *P. ilicis*, and 1 U.S. quart 50 per cent. toxaphene emulsion concentrate and 4 lb. wettable sulphur both gave inferior immediate kill of *P. ununguis*. Sprays of p-chlorophenyl p-chlorobenzene-sulphonate [Ovotran] at 1–2 lb. 50 per cent. wettable powder or 35 fl. oz. emulsion concentrate containing 1·8 lb. chemical per U.S. gal. tended to be slow in action against large motile mites.

Toxaphene, wettable sulphur and the lower concentration of selenium had a very short residual effect, whereas Aramite and DMC were variable, with inferior persistent action where conditions were severe (low concentration, excessive rainfall, midsummer temperature and humidity) ; DMC usually prevented mite increase for more than a month, and Aramite had somewhat more prolonged action in emulsion than in suspension, but was inferior to DMC and Ovotran at the concentrations tested. Ovotran consistently showed long residual action, preventing excessive mite increase for the whole period of observation, and is considered to satisfy the requirements necessary for single applications against either species. EPN also showed excellent residual action. Systox was so variable in durability that more work is required before it can be evaluated.

STEINER (L. F.) & HINMAN (F. G.). **Field Tests of Insecticides for Control of Oriental Fruit Fly.**—*J. econ. Ent.* **45** no. 3 pp. 388–395, 3 refs. Menasha, Wis., 1952.

The following is substantially the authors' summary. Preliminary small-plot field tests with several of the new organic insecticides on banana and wild guava in Hawaii in 1950 indicated that *Dacus ferrugineus dorsalis* Hend. can be controlled by some of them. The best materials were wettable-powder sprays of parathion at 1·7–2·2 lb. per acre, Dilan (a 2 : 1 mixture of 1,1-bis(p-chlorophenyl)-2-nitrobutane and 1,1-bis(p-chlorophenyl)-2-nitropropane) or DDT at 3·4–5·2 lb., and a mixture of 2·25 lb. DDT and 0·14 lb. parathion. EPN [O-ethyl O-p-nitrophenyl benzenethiophosphonate], aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], dieldrin [1,2,3,4,10,10-hexachloro-6,7,epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and lindane [at least 99 per cent. γ benzene hexachloride] at 0·85–2·2 lb. per acre were promising when applied at intervals of two weeks to banana and of three to guava. These materials gave average reductions in fruit infestation of 80–96 per cent., despite a steady influx of flies from contiguous unsprayed areas and a substantial depressing influence of the sprays on fly populations in the unsprayed plots used for comparison.

At the concentrations used, all the materials were highly effective as space sprays against the fruit-flies present at the time of application, and should give complete control for two or more weeks in the absence of reinfestation from outside areas. At the higher concentrations, residues of parathion, EPN, DDT, dieldrin and aldrin were generally effective for 2–3 weeks; residues from emulsifiable formulations were less effective than those from wettable powders.

Parathion, dieldrin and aldrin applied at rates of 1·7 lb. toxicant per acre killed all fruit-flies in cages exposed in the plots, but not touching any sprayed surface, for as long as four days after application, and EPN and lindane gave some mortality. Death was chiefly the result of fumigating action, but contact with airborne particles of insecticide may also have been involved.

Applications of dieldrin and aldrin to guava permitted a serious outbreak of the Tortricid, *Amorbia emigratella* Busck, as a result of their comparative ineffectiveness against the larvae and their extremely high toxicity to the Argentine ant [*Iridomyrmex humilis* (Mayr)], which contributes extensively to its control. Although the other materials, with the exception of lindane, also depressed populations of the ant, they were toxic to *Amorbia* larvae.

Parasitism of *Dacus* by *Opius* spp. was negligible on banana. On guava, it was 2–11 per cent. in the plots sprayed with aldrin and dieldrin, 26–69 per cent. in plots sprayed with other insecticides and 46–50 per cent. in the unsprayed plots. The results indicated that certain of the parasites moving in from contiguous unsprayed areas were soon able to parasitise at least as high a proportion of the larvae in areas sprayed with 2·25 lb. DDT or Dilan, 1·4 lb. EPN or 0·85 lb. parathion per acre as in untreated areas.

FRINGS (H.). **Factors determining the Effects of Radio-frequency Electromagnetic Fields on Insects and Materials they infest.**—*J. econ. Ent.* **45** no. 3 pp. 396–408, 9 graphs, 35 refs. Menasha, Wis., 1952.

The author reviews the literature on the effects of radio-frequency (RF) electrostatic fields on insects and materials infested by them [*cf. R.A.E.*, A **36** 15, etc.] and describes investigations with various insects carried out in connection with the suggestion that eggs and larvae of *Dacus ferrugineus*

dorsalis Hend. in fruits might be controlled by this means without heating the fruits appreciably. The possibility of this seemed small. The following is virtually the author's summary of the paper.

Fruits and vegetables are heated and insects are killed when placed in radio-frequency (3–27 megacycles per sec.) electrostatic fields. The main cause of death in insects is dielectric heating, which may be general or localised. The rate of heating of treated objects is determined by the frequency and average voltage gradient of the RF field, the vertical fraction of the field occupied by the treated object if an air space is present, the chemical and physical state of the object (in insects this may be a reflection of age, sex or physiological condition) and the shape of the object. The last is of special importance in insects with appendages; the legs may act as conducting paths that heat strongly long before any generalised heating occurs. This probably accounts for the fact that adult insects with complete metamorphosis are knocked down almost immediately and killed very rapidly by an RF field, whereas the larvae are not knocked down and are killed much more slowly. No critical differential in heating at various frequencies between plant and animal tissues was found. It is probably impossible to heat an insect inside a fruit or vegetable without heating the plant material also.

If results of experiments with RF fields in insect control are to be reproducible, the following information must be given about the treated materials: size and shape, age, sex and physiological state of treated insects, and exact "death-point" of the insect used or, preferably, the actual change in temperature. The following information about the treatment conditions must also be given; time of treatment, frequency and average voltage gradient of the RF field, and, if an airgap is present, the vertical fraction of the field occupied by the object. In the present state of knowledge, the study of possible practical utilisation of RF fields for insect control remains chiefly empirical.

Gaines (J. C.) & Mistric jr. (W. J.). **Effect of environmental Factors on the Toxicity of certain Insecticides.**—*J. econ. Ent.* **45** no. 3 pp. 409–416, 1 graph, 4 refs. Menasha, Wis., 1952.

An account is given of cage tests made on cotton in the laboratory and field at College Station, Texas, in 1951 to obtain additional information on the effect of sunshine, dew and rain on the toxicity of sprays to adults of the weevil, *Anthonomus grandis* Boh., and larvae of *Alabama argillacea* (Hb.), *Loxostege similalis* (Gn.) and *Estigmene acraea* (Dru.) [*cf. R.A.E.*, A **40** 113, etc.]. All sprays were prepared from miscible oil concentrates, and the following is based partly on the authors' summary of the results.

Field-cage tests showed that the overwintered weevils were more susceptible to toxaphene sprays than those reared from squares during the early fruiting season, apparently owing to the depletion of food in the former. About four times as much toxaphene per acre was required to kill as high a proportion of weevils reared from bolls as from squares, indicating that the type of food on which the weevils develop affects their susceptibility to toxaphene, and four or more times as much of any toxicant was required for mortality in the field to equal that obtained in the laboratory, factors such as high temperatures, sunshine, wide ranges in relative humidity, dew or a combination of them greatly reducing effectiveness. An experimental mixture of chlorinated terpene isomers, toxaphene, EPN (O-ethyl O-p-nitrophenyl benzenethiophosphonate) and dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] retained their toxicity to weevils when

exposed to these environmental conditions better than parathion, S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate [malathon], aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], a stereoisomer of aldrin and one of dieldrin, and a mixture of γ BHC (benzene hexachloride) and DDT, the toxicity of all of which was greatly reduced. The dosages required to control the weevils were higher late in the season than early in it, possibly owing to differences in food as well as in weather.

Experiments against *A. argillacea* showed that the median lethal dosages (in lb. per acre) of the various insecticides to third-instar larvae in the laboratory were 0·069 for the chlorinated terpene isomers, 0·064 and 0·009 for aldrin and its stereoisomer, 0·018 and 0·002 for dieldrin and its stereoisomer, 0·002 for EPN and parathion, 0·022 for malathon, and 0·076 for toxaphene and the mixture of γ BHC and DDT, but the toxicity of all of them was greatly reduced by high temperatures and sunshine. In the tests with *L. similalis*, 0·25 lb. aldrin, dieldrin and the stereoisomer of dieldrin, 1 lb. toxaphene and 0·05 lb. EPN per acre gave 42·6, 93, 100, 89·5 and 100 per cent. mortality, respectively, of third-instar larvae placed on sprayed plants immediately after treatment and 21·1, 38·6, 82·5, 77 and 62·6 per cent. of those placed on them after 24 hours in the open, and the average figures for several rates of application showed that toxaphene and EPN were less affected by high temperatures and sunshine than the other materials.

Against *E. acraea*, 0·35 lb. toxaphene, 0·025 and 0·1 lb. of the stereoisomers of dieldrin and aldrin, respectively, and 0·015 lb. parathion per acre gave 97·43, 94·73, 94·73 and 82·22 per cent. mortality of third-instar larvae placed on sprayed plants immediately after treatment, and 81·24, 73·65, 61·82 and 22·4 per cent. after the application of 0·5 in. simulated rain ; malathon and EPN at 0·015 lb. per acre gave only 9·15 and 27·19 per cent. kill, and the effect of rain on them was not tested.

Ahmed (D. D.), App (B. A.), Everly (R. T.) & Davidson (R. H.). **Tests for Control of Meadow Spittlebugs in Ohio.**—*J. econ. Ent.* **45** no. 3 pp. 417–420, 16 refs. Menasha, Wis., 1952.

In 1948, sprays containing organic insecticides were applied against nymphs of *Philaenus leucophthalmus* (L.) in a field of mixed hay, including red clover, at Columbus, Ohio. Counts of nymphs on sample areas a week later showed that BHC (benzene hexachloride) at 1 lb. γ isomer per acre in suspension or emulsion sprays gave almost complete control, and DDT at 4 lb. in an emulsion spray, chlordan at 2 lb. in either and toxaphene at 2 lb. in a suspension were not significantly less effective, whereas 4 lb. wettable or colloidal DDT and 1 lb. wettable parathion gave significantly less control and pyrethrins synergised with piperonyl butoxide or piperonyl cyclonene and rotenone synergised with piperonyl cyclonene were ineffective.

In 1949, on red clover, γ BHC, methoxy-DDT (methoxychlor), aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] and heptachlor [1(or3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene] in suspension sprays and chlordan in an emulsion gave similar results whether applied on 6th May, before all the eggs had hatched, or 17th May, when hatching was believed to be complete, whereas toxaphene in emulsion was much less satisfactory on the second date ; BHC at 1 lb. γ isomer and methoxy-DDT at 8 lb. per acre were more effective than chlordan, heptachlor or toxaphene at 2 lb. or aldrin at 1 lb. per acre.

In outdoor cage-tests with wettable powder sprays against adults on clover in pots in August 1949, DDT and methoxy-DDT gave 95 and 98 per cent. reduction in population at 2 lb. per acre, whereas γ BHC, toxaphene and chlordan gave 71, 50 and 38 per cent. at the same rate.

Cox (H. C.) & Lilly (J. H.). **Effects of Aldrin and Dieldrin on Germination and early Growth of Field Crop Seeds.**—*J. econ. Ent.* **45** no. 3 pp. 421–428, 2 graphs, 5 refs. Menasha, Wis., 1952.

The following is based on the authors' introduction and summary. The effects of various concentrations of aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] and dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene], applied as soil insecticides, on the germination and early growth of field crops that are grown commercially in the Middle West of the United States were tested in the greenhouse under conditions considered to be far more severe than would be encountered in the field. The seeds were sown in washed river sand, and commercial wettable powders containing 23·8 per cent. aldrin and 17·9 per cent. related compounds (considered to be the equivalent of 25 per cent. aldrin), or 21·2 per cent. dieldrin with 3·8 per cent. related active compounds (equivalent to 25 per cent. dieldrin) were applied at seven rates ranging from 2 to 128 lb. technical insecticide per acre in a commercial fertiliser used at 200–300 lb. per acre and compared with no treatment.

After treatment with aldrin, maize, flax and soy beans showed good emergence and growth at all dosages, and barley emerged and grew well at levels up to 32 lb. and gave fair responses at 64 and 128 lb. Buckwheat and winter wheat emerged and grew well after treatment at 8 lb. and fairly well at higher rates, and oats and rye germinated and grew well at 2 and 4 lb., fairly well at 8 and 16 lb. and poorly at higher rates. All these crops emerged and grew well after all dieldrin treatments.

There were indications that some of the treatments slightly improved germination ; this was most obvious for winter wheat and maize after treatment with 2 and 4 lb. aldrin and all rates of dieldrin. There was also evidence of slight growth stimulation by both aldrin and dieldrin at 2 and 4 lb. on several of the crops, but some growth defects and stunting were noted. Treatment with 64 or 128 lb. aldrin caused the young plants of both barley and winter wheat to grow out at various angles from the sand surface and resulted in chlorosis of the wheat.

When honey sorghum was grown in sand treated with the commercial aldrin or with a wettable powder containing 25 per cent. recrystallised aldrin, much better germination and growth were obtained with the latter, indicating that the materials associated with aldrin in the commercial preparation were more phytotoxic than pure aldrin.

Since the lowest dosage tested is higher than would normally be used in the field, these materials appear unlikely to damage the common crops, with the possible exception of sorghums, which need to be tested in the field.

Ginsburg (J. M.), Filmer (R. S.) & Reed (J. P.). **Recovery of organic Insecticides from sprayed and dusted Crops.**—*J. econ. Ent.* **45** no. 3 pp. 428–431, 3 refs. Menasha, Wis., 1952.

Chemical analyses were made in New Jersey in 1951 of insecticide residues remaining on clover sprayed with crude BHC (benzene hexachloride) or lindane [at least 99 per cent. γ BHC], on lucerne dusted with lindane, aldrin [1,2,3,4,10,-10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] or toxaphene and on maize dusted and onions sprayed with S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate [malathon].

No toxic residues were recovered at harvest on 7th–18th June from clover treated with 0·2–0·5 lb. lindane per acre as a wettable-powder or emulsion

spray on 30th April or on lucerne dusted with 0·2 lb. lindane per acre on 23rd April, and only low residues 5 and 16 days after treatment. Crude BHC as a wettable powder applied at 0·24 lb. γ isomer per acre left considerably higher residues than lindane on clover after 5 and 16 days, though only 1 part per million was found at harvest, 38 days after treatment. No residues were found on lucerne 49 days after single dust applications at 40 lb. per acre of 3 per cent. dieldrin or 5 per cent. toxaphene, and only 0·3 p.p.m. 49 days after an application of 2·5 per cent. aldrin at the same rate.

No residues were recovered from maize 21 days after the last of four applications of 40 lb. 2 or 4 per cent. malathon per acre, or from onions 11 days after one application of an emulsion spray at the rate of 1·25 lb. malathon per acre and subsidiary tests with dusts on lima beans and lettuce showed that malathon undergoes rapid decomposition on plants, leaving practically no residue three days after application.

It was observed in the course of the work that BHC gave excellent control of *Philaenus leucophthalmus* (L.) (*spumarius*, auct.) on clover and lucerne, resulting in substantial increases in forage yields, and that malathon gave good control of *Epilachna varivestis* Muls. (*corrupta* Muls.) on lima beans, fair control of *Thrips tabaci* Lind. on onion and some control of *Pyrausta nubilalis* (Hb.) on maize.

ARMITAGE (H. M.). **Controlling Curly Top Virus in agricultural Crops by reducing Populations of overwintering Beet Leafhoppers.**—*J. econ. Ent.* **45** no. 3 pp. 432–435, 3 figs. Menasha, Wis., 1952.

The author describes measures adopted to prevent infestation of crops by *Circulifer tenellus* (Baker) in the San Joaquin Valley of California, where the curly-top virus, of which it is the only known vector, causes serious annual losses of tomato, melon, cucumber, beans and spinach over large areas. The leafhopper passes through three or more generations in summer on crops and weeds in the valley and moves to the foothills for the winter when the crops are harvested. As the winter food-plants there have not normally developed by that time, the leafhoppers maintain themselves on perennial plants, chiefly *Atriplex* spp., at the mouths of the canyons, and the concentrations resulting can be effectively destroyed by insecticides for about six weeks from 1st November. With the first winter rains, the leafhoppers move to more attractive plants, and remain concentrated for a short time in the canyons, where they can be destroyed from about 15th December to 1st February. They later disperse so widely as to make treatment useless, but in spring, they concentrate once again on sparse growth on low knolls with a warm southerly exposure to produce the spring migrating generation, and numbers can be reduced by further treatment between 1st March and 25th April. DDT in diesel oil is applied at all these times as an aerosol at the rate of 1 lb. in 2 U.S. gals. oil per acre by aeroplane or from a ground machine of the turbine-blower type. Movement of the leafhoppers into the foothills in autumn is progressive from north to south, and that from the foothills in spring from south to north [*cf. R.A.E.*, A **37** 93], and spray operations are timed accordingly. Only the major concentrations of insects are treated, but numbers can be so reduced that a minimum of crop damage is caused. Since the females migrate for up to 80–120 miles to cultivated crops in a single night between 15th and 20th April, susceptible crops should be planted as late as possible, preferably not until after 20th April.

Ways in which the time and extent of winter rainfall affect control are discussed. A series of years of low rainfall has recently resulted in the growth of heavy stands of Russian thistle [*Salsola*] over large areas of open range land between the agricultural areas and the foothills. This has favoured the production of epidemic populations of the leafhopper by autumn [*cf.* **36** 397], and

unless these are reduced materially before they move to the foothills, the winter programme becomes impracticable. Treatment must generally be carried out between 1st and 20th October, when all the eggs have hatched but few adults have migrated. In 1950, 141,000 acres were treated from the air with DDT at 2 lb. in 4 U.S. gals. oil per acre, resulting in almost total absence of virus infection in tomato in 1951, and in 1951, 150,000 acres were sprayed at 1·5 lb. in 2 U.S. gals. oil per acre with similar results.

Rings (R. W.). **Experimental Control of Plum Curculio on Peaches.**—*J. econ. Ent.* **45** no. 3 pp. 436–444, 3 refs. Menasha, Wis., 1952.

Further investigations on the control of *Conotrachelus nenuphar* (Hbst.) on peach in Ohio were carried out in 1948–51 [*cf. R.A.E.*, A **37** 430]. Spraying was begun in the field at the shuck-split stage, except in 1948, when it was begun in petal-fall, each treatment was applied three times at intervals of ten days, and wettable sulphur was included in each spray for the control of brown rot [*Sclerotinia fructicola*]. Treatments were evaluated by reference to the differences in adult and larval populations, the protection afforded to the crop and the infestation in dropped fruits. In addition, some materials were tested separately in the field for their effect on the flavour of the processed peaches and in cages by a method already noticed [**38** 429]. All spray quantities are given per 100 U.S. gals.

Lead arsenate at 2 lb. was used as the standard of comparison in the orchard in 1948 and 1949. In cage tests, it acted very slowly, killing only 20 per cent. of the adults in six days. Control of the larvae by technical BHC (benzene hexachloride) was poor in 1948, when it was used at 0·18 lb. γ isomer, but excellent later at 0·25 lb. γ isomer. In cage tests, it knocked down 10–85 per cent. of the adults in 132 hours, but some recovered. It affected the flavour of the peaches if used in more than two applications. Lindane [at least 99 per cent. γ BHC] at about 0·25 lb. γ isomer was more effective than technical BHC against the larvae in 1948, but showed little toxicity to adults. It affected peach flavour when applied with micronised sulphur or with this and polyethylene polysulphide, but not when applied alone four times, the last being 88 days before harvest. Methoxy-DDT (methoxychlor) at 1 lb. caused rather slow knockdown of adults in cage tests, but death occurred soon thereafter. It gave very good results in the field, where it was excelled only by dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and EPN (O-ethyl O-p-nitrophenyl benzenethiophosphonate), in 1950. Residues were very persistent, but flavour was not affected. Its disadvantages are that it is ineffective against the oriental fruit moth [*Cydia molesta* (Busck)] and has a tendency to result in increased mite populations. DDT at 1 lb. was ineffective in cage tests ; it did not affect fruit flavour.

Two samples of chlordan from different manufacturers differed greatly in toxicity. The better one, used at 1 lb., was superior to lead arsenate and technical BHC and at least as good as lindane in 1948, knocked down all the adults in nine hours in cage tests in 1949 and had no effect on fruit flavour when applied three or four times. Toxaphene at the same concentration gave such poor results in 1948 that it was not further tested ; it did not significantly impair flavour. Aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] at 0·25 lb. proved more toxic to adults of the summer generation than any other chlorinated hydrocarbon but dieldrin and heptachlor [1(or3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene], giving complete knockdown in 12–36 hours. The beetles remained apparently moribund for two days and some later recovered. It gave good control of the larvae in the field in 1950 and 1951 and did not affect

flavour. Dieldrin at 0·225–0·25 lb. gave rapid knockdown of adults, and there was no recovery. It gave excellent control in field tests in 1950 and 1951, causing 77·6 per cent. reduction in the population of adults of the spring generation and the greatest reduction (98·6 per cent.) in larval populations of any material tested in 1950, with no effect on fruit flavour. Heptachlor at 1 lb. knocked down the adults rapidly in cage tests but was slow in lethal action. In 1951, it was outstanding in control of the larvae (giving 95·7 per cent. reduction) and in protecting the fruit from attack and did not affect its flavour. Parathion was very toxic to summer adults in cage tests, the beetles dying soon after they showed initial symptoms of poisoning. It was used at 1 or 2 lb. 25 per cent. wettable powder in 1948–49 and at 2 lb. 15 per cent. wettable powder in 1950–51. It gave excellent control at the higher dosage in 1948, but had not enough residual effect in 1950 to control females ovipositing late in the season, so that much fruit was injured and many larvae were reared from dropped fruits after 18th July. Fruit flavour was not affected.

Fresh deposits from a spray of tetraethyl pyrophosphate at 0·4 lb. gave quick knockdown, but toxicity decreased rapidly, and mortality of beetles that fed for 102 hours on foliage treated ten days previously was only 20 per cent. It was not tested in the field. EPN was tested at several concentrations, of which 1·5 lb. 25 per cent. wettable powder appeared to be the most practical. It gave complete kill of beetles in 12–24 hours in various cage tests and good results in the field ; although somewhat less effective than dieldrin and methoxy-DDT in reducing larval populations, it was more effective in protecting the fruit from oviposition punctures. It was more resistant to weathering than parathion and did not affect fruit flavour. EON (O-ethyl O-o-nitrophenyl benzenethiophosphonate) was similar in effect to EPN in cage tests, but appeared to have a little better residual action. It was not available for use in the field.

In further cage tests, 1,1-bis(p-chlorophenyl)-2-nitrobutane gave poor results, but 1,1-bis(p-chlorophenyl)-2-nitropropane and a mixture of the two (2 : 1) were promising. Schradan (octamethyl pyrophosphoramide) at 2 lb. 40 per cent. emulsifiable concentrate killed only 10 per cent. of the adults in 132 hours by contact action and none by systemic action. Malathon (S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate) gave good results in cage tests at 2–4 lb. 50 per cent emulsifiable concentrate, but was inferior in the orchard at 3 lb. 25 per cent. wettable powder and affected fruit flavour adversely. When used at 2 lb. 32·1 per cent. emulsion concentrate in cage tests, Systox (a trialkyl thiophosphate [O-(2-(ethylmercapto)ethyl) O,O-diethyl thiophosphate]) was ineffective against the adults by contact action, but gave complete mortality in 36 hours by systemic action. In the field, it caused 57 per cent. reduction in the larval population, but failed to give commercial control ; there was a residue on the fruits of 2 parts per million 73 days after the last of three sprays, but flavour was not affected. Potasan (diethoxythiophosphoric acid ester of 7-hydroxy-4-methyl coumarin) at 1 lb. 31 per cent. concentrate killed 85 per cent. of the beetles in 132 hours by contact action and 80 per cent. by systemic action, and ethyl-DDD (1,1-bis(p-ethylphenyl)-2,2-dichloroethane) killed all beetles in 84 hours at 1 lb. and in 48 hours at 2 lb. ; these were not tested in the field.

SIEGLER (E. H.). **Residual Toxicity of some organic Insecticides to Japanese Beetles.**—*J. econ. Ent.* **45** no. 3 pp. 449–451, 1 ref. Menasha, Wis., 1952.

An account is given of laboratory tests in Maryland in 1951 in which various organic insecticides were applied in sprays to caged field-collected adults of *Popillia japonica* Newm. or to empty cages in which the beetles were subsequently confined. Slices of apple were provided as food. All spray quantities

are given per 100 U.S. gals. Parathion at 0·1–0·2 lb. 25 per cent. wettable powder gave complete mortality of sprayed beetles in 3–4 days and good and increasing mortality of beetles exposed to residues 4, 7 and 14 days old after the first day of exposure, when control was poor. EPN [O-ethyl O-p-nitrophenyl benzenethiophosphonate] at 0·09 lb. 27 per cent. wettable powder was less effective, but also gave increased mortality with increased exposures. DDT at 1 lb. and methoxy-DDT (methoxychlor) at 0·5 lb. 25 and 50 per cent. wettable powders, respectively, were very effective as direct sprays and as residues 7–14 days old, and aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] at 0·5 lb. 25 per cent. wettable powder or 0·68 lb. 18·5 per cent. emulsion concentrate gave complete mortality of sprayed beetles within one day and kills increasing with length of exposure to residues 4–14 days old, though the latter were less effective than those of DDT. Dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] gave complete mortality in one day as a direct spray and as residues 4–6 days old when used at 0·5 lb. 25 per cent. wettable powder, and in 1, 2 and 3 days, respectively, as residues 7 and 14 days old from 1 lb. 25 per cent. wettable powder and 6 days old from 0·68 lb. 18·5 per cent. emulsifiable concentrate. Toxaphene at 2 lb. 40 per cent. wettable powder gave complete mortality in one day as a direct spray, and was slower in action than DDT but increased in effectiveness with exposure as residues 7 and 14 days old. Wettable BHC (benzene hexachloride) at 2 lb. 10 per cent. γ isomer gave complete mortality in one day in direct sprays and in two days as residues 7 and 14 days old. At 0·5 lb., it was as effective in the direct spray, but did not give complete mortality in three days in residues 6 days old.

MARCH (R. B.). **The Resolution and chemical and biological Characterization of some Constituents of technical Chlordane.**—*J. econ. Ent.* **45** no. 3 pp. 452–456, 3 figs., 9 refs. Menasha, Wis., 1952.

The following is substantially the author's summary. By means of chromatographic adsorption techniques, technical chlordan was separated into four physically, chemically and biologically distinct crystalline constituents and an unknown liquid mixture. The four distinct constituents are postulated to be : 4,5,6,7,8,8 - hexachloro - 3a,4,7,7a - tetrahydro - 4,7 - methanoindene ; 1(or3a), 4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene ; and the cis and trans isomers of 2,3,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene. It did not appear that endo-exo isomer pairs were present, and it was not determined whether the isomers obtained were endo or exo. Higher chlorinated derivatives were not found in the sample of technical chlordan tested. Compounds identical with the second, third and fourth constituents have been commercially synthesised in pure form. They are known as heptachlor and the α and β isomers of chlordan.

Topical application of the toxicants dissolved in dioxane to the scutella of adult females of *Oncopeltus fasciatus* (Dall.) showed that the dosages giving 50 per cent. mortality in 96 hours were 143 ± 2 mmg. per gm. average insect weight for technical chlordan, more than 1,000, 31 ± 1, 459 ± 14 and 47 ± 1 mmg. per gm. for the four crystalline constituents in the order listed and 232 ± 7 for the liquid mixture.

HENDERSON (C. F.), HORD (L. G.) & MILLET (E. R.). **Reduction in White-fringed Beetle Injury by DDT Treatments.**—*J. econ. Ent.* **45** no. 3 pp. 457–461, 1 graph. Menasha, Wis., 1952.

An account is given of investigations in Mississippi on the environmental conditions most conducive to economic damage by *Graphognathus peregrinus*

(Buchanan), one of several species of white-fringed beetles known to injure crops in the south-eastern United States. They included observations on larval populations and crop damage in fields having different histories of cultivation, before and after treatment of the soil with DDT, and comparative counts of pasture plants and weeds on treated and untreated soil.

Examination of nine fields of cotton and seven of maize in 1947 showed that there were average losses of 53 per cent. of the cotton plants and 43 per cent. of the maize due to injury by the larvae in untreated ground, and there was a positive correlation between plant stand and crop yield; the reduction in yield of living but stunted plants was not considered. The soil was treated with 10 lb. DDT in 12 U.S. gals. suspension per acre between 18th February and 25th March 1948 and disked as soon as possible, usually within 24 hours. As a result, larval populations were reduced by 90–99 per cent. between February (just before treatment) and May–June 1948 and by 79–98 per cent. between May–June 1947 and May–June 1948, whereas populations increased greatly in untreated fields. When the soil treatments were begun, 56 per cent. of the larvae were small and 41 per cent. medium in size, indicating that the treatments were made at a favourable time, since DDT soil applications are known to be effective against small and medium-sized larvae. The surviving larvae damaged no cotton plants and a negligible amount of maize. It appears, therefore, that a single application of DDT at 10 lb. per acre reduces larval populations below economic levels if disked into the soil at once, and it is possible that the treatment may remain effective for several years.

The greatest plant injury (32 per cent.) found on any one date and the highest larval population (101 per sq. yard) were in fields that had not been cultivated for one year, and the next largest in fields that had lain idle for five or more years. The least plant injury (24 per cent.) and the lowest larval population (58 per sq. yard) were found in fields that had been in continuous cultivation for five years.

Since land that has lain idle for some years and pastures that have received only occasional disking contain pasture plants and weeds that may be killed by larvae of *G. peregrinus*, the effectiveness of DDT in reducing injury to such plants was tested. When applied at 5 or 10 lb. in 60 U.S. gals. emulsion or suspension spray per acre in May 1946 or at 25 lb. in a suspension in August 1947 and disked in, DDT reduced larval populations and led to considerable increase in growth of native plants in the following year. A single soil application in May 1946 of 5 or 10 lb. DDT in 6 U.S. gals. emulsion or suspension per acre was ineffective against larvae of the first generation in the soil of a weedy pecan grove, and populations were high in the spring of 1947, but five applications of 1 lb. DDT in 6 U.S. gals. emulsion spray per acre to weed foliage during the season of adult emergence in 1947 gave high adult mortalities followed by extremely low populations of first-generation larvae and considerable increases in plant stand the following year.

HAMILTON (D. W.), MCALISTER (H. J.), SUMMERLAND (S. A.) & FAHEY (J. E.). **Control of Pests attacking Apples, Peaches, and Pears with Nitroparaffin Compounds.**—*J. econ. Ent.* **45** no. 3 pp. 462–466, 1 ref. Menasha, Wis., 1952.

Two nitroparaffins, Prolan [1,1-bis(p-chlorophenyl)-2-nitropropane] and Bulan [1,1-bis(p-chlorophenyl)-2-nitrobutane] were tested in sprays for the control of insects attacking peach and pear at Poughkeepsie, New York, in 1949, and Dilan, a 1 : 2 mixture of them, against those attacking apple and peach at Vincennes, Indiana, in 1950 and 1951. All spray quantities are given per 100 U.S. gals. On peach, 2 lb. wettable powder containing 50 per cent.

Bulan, Prolan or DDT or 25 per cent. parathion reduced the percentage of fruits damaged by a light population of *Cydia* (*Grapholitha*) *molesta* (Busck) in New York from 4 to 0·1, 0·6, 0·4 and 0, respectively, and 1 U.S. quart 25 per cent. Dilan emulsion concentrate with a pine-oil base gave adequate control of *C. molesta*, *Conotrachelus nenuphar* (Hbst.) and *Eulia* (*Argyrotaenia*) *velutinana* (Wlk.) in Indiana when applied seven times between 17th April and 14th July, and compared favourably with 1·5 lb. 15 per cent. wettable parathion, 1 lb. 25 per cent. wettable EPN [O-ethyl O-p-nitrophenyl benzene-thiophosphonate] or 2 lb. 25 per cent. wettable aldrin [1,2,3,4,10,10-hexa-chloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], the last with the addition of 2 lb. 50 per cent. wettable DDT in the last application. Dilan did not satisfactorily control *Lygus oblineatus* (Say) and Pentatomids on peach in Indiana, but was little inferior in this respect to the other materials tested.

On pear, applications of 1 U.S. pint emulsion concentrate containing 25 per cent. Prolan or Bulan on 14th July gave good control of *Psylla pyricola* Först., and were more lasting in effect than a standard spray of cubé and summer oil.

On apple, Dilan was tested at 3 or 4 U.S. pints of the emulsion concentrate or 2·5 or 4 lb. 25 per cent. wettable powder impregnated on tobacco stems in seven cover sprays, and at 2 lb. 18 per cent. wettable powder in the first four and 2 lb. 50 per cent. wettable powder in the last three. It compared favourably with 2 lb. 50 per cent. or 1·25 lb. 75 per cent. wettable DDT and was superior to 1·5 lb. 15 per cent. wettable parathion against *Cydia* (*Carpocapsa*) *pomonella* (L.), and controlled *E. velutinana* and *Conotrachelus nenuphar* as well as parathion and better than DDT. In tests in which field-sprayed apples were removed at intervals during the spray period and infested with larvae of *Cydia pomonella*, 4 lb. of the wettable Dilan on tobacco stems proved superior to 2·5 lb. and compared favourably with 1·25 lb. 75 per cent. DDT and 1·5 lb. 15 per cent. parathion. When sprays were applied in the laboratory to leaves infested by larvae of *E. velutinana* or sprayed leaves were infested with them, 4 lb. wettable Dilan on tobacco stems was nearly as effective as 1·5 lb. 50 per cent. wettable DDD (TDE) [dichlorodiphenyldichloroethane] and superior to 2 lb. of the wettable Dilan, which was used in the second type of test only. Some of the trees in one orchard were infested by *Aphis pomi* Deg., and the percentages of infested terminals after the third cover spray were 17 and 56 on trees receiving 3 U.S. pints of the Dilan emulsion concentrate and 2 lb. 18 per cent. wettable Dilan, respectively, 24 and 42 on those receiving 1·5 lb. 15 per cent. parathion and 1·25 lb. 75 per cent. DDT and 96 on those receiving a fungicide only. The apparent effectiveness of the Dilan emulsion is attributed to the pine oil in it.

The nitroparaffins did not control *Paratetranychus pilosus* (C. & F.) or *Tetranychus bimaculatus* Harvey, large numbers of both of which were observed on apple and peach sprayed with Dilan. Populations were heavier on trees that had been sprayed with the wettable powders than on those receiving the emulsion, possibly again because of the pine oil in the latter. Residue analyses on peach and apple fruits indicated that deposits of Dilan are relatively stable and should afford protection for an extended period ; 25 per cent. Dilan on tobacco stems gave the heaviest initial deposit. Dilan was used in both emulsion and wettable-powder sprays with tetraethyl pyrophosphate and Aramite [2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite] (against mites) and with wettable sulphur, ferbam [ferric dimethyldithiocarbamate] and N-(trichloromethyl mercapto) tetrahydrophthalimide (against fungous diseases) on red apples and peaches of several varieties without causing visible injury to the fruits or foliage; it has not been tested on yellow varieties of apple.

ANDERSON (L. D.) & TUFT (T. O.). **Toxicity of several new Insecticides to Honey Bees.**—*J. econ. Ent.* **45** no. 3 pp. 466–469, 12 refs. Menasha, Wis., 1952.

The following is based largely on the authors' summary. In laboratory toxicity tests in which honey bees were dusted in small cages, 1 per cent. malathon (S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate), parathion or lindane [at least 99 per cent. γ BHC (benzene hexachloride)], 2 per cent. EPN [O-ethyl O-p-nitrophenyl benzenethiophosphonate] and technical BHC at 2 per cent. γ isomer gave complete kills in less than an hour and 5 per cent. chlordan and 1 per cent. heptachlor [1 (or 3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene], aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] or dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethano-naphthalene] within six hours, whereas 5 per cent. DDT or O,O-diisopropyl O-p-nitrophenyl thiophosphate and 10 per cent. toxaphene gave 98–100 per cent. kill in 18 hours. Methoxy-DDT (methoxychlor) and ethyl-DDD (2,2-bis(p-ethylphenyl)-1,1-dichloroethane) at 5 per cent. and Sulphenone (p-chlorophenyl phenyl sulphone) at 10 per cent. required 72 hours to give 73–89 per cent. kill and DDD (TDE) [2,2-bis(p-chlorophenyl)-1,1-dichloroethane] at 5 per cent. gave only 42 per cent. kill in 72 hours.

Aramite (2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite), 2,4-dichlorophenyl benzenesulphonate and Ovotran (p-chlorophenyl p-chlorobenzenesulphonate), and diluents such as pyrophyllite silicate, calcite carbonate, calcium carbonate, magnesium carbonate and hydrated lime, were relatively non-toxic. An attapulgite clay silicate was somewhat toxic alone, but not when mixed with pyrophyllite silicate (1 : 9). A diatomaceous earth, silicon oxide (Celite), gave high mortality in 18 hours in one test, and sulphur was also very toxic but can be safely used in the field as the bees are repelled by it. Karathane (dinitrocaprylphenylcrotonate) and DMC [1,1-bis(p-chlorophenyl)-ethanol] at 3 per cent. were relatively non-toxic, whereas Neotran (di(p-chlorophenoxy) methane) at 5 per cent. gave high mortality in 24 hours.

When the bees were confined with dusted bunches of flowers, complete mortality was given by 1 per cent. parathion or malathon and 2 per cent. EPN in five hours, 5 per cent. DDT in 50, and 5 per cent. of the diisopropyl compound in 66; the other materials tested in this way were relatively non-toxic. Field observations in California showed that DDT and toxaphene caused no serious losses of bees, whereas dieldrin, parathion, chlordan and BHC were very injurious; parathion was carried to the hive where it killed brood and other hive bees and contaminated the honey.

MICHELBACHER (A. E.), MIDDLEKAUFF (W.), BACON (O. G.) & GLOVER (L. C.). **Aldrin, Dieldrin and Heptachlor to control California Melon Insects.**—*J. econ. Ent.* **45** no. 3 pp. 470–475, 2 refs. Menasha, Wis., 1952.

Since aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] and dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] showed considerable promise against *Liriomyza subpusilla* (Frost) and other insect pests of melons in California in 1950 [*R.A.E.*, A **39** 344], further tests were made in 1951. Aldrin, dieldrin and heptachlor [1 (or 3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-endomethanoindene] were used in concentrated emulsion sprays and as dusts and were compared in some tests with dusts of DDT.

The following is based on the authors' summary of the results. Aldrin, dieldrin and heptachlor were all effective against *L. subpusilla*, dieldrin giving

satisfactory control at 8–12 oz. per acre and the other two at 12–16 oz. Sprays were somewhat superior to dusts, and a single treatment should remain effective for at least three weeks. DDT gave no control of *L. subpusilla*, but did not appear to favour infestation by it. Aldrin, dieldrin and heptachlor all gave highly satisfactory control of *Diabrotica undecimpunctata* Mannh. and *Acalymma trivittata* (Mannh.), but only dieldrin showed promise against *Empoasca abrupta* DeL. Dieldrin and aldrin apparently had some repressive effect on *Aphis gossypii* Glov., and heptachlor at least did not favour its increase. All three materials tended to favour increases in mites, chiefly *Tetranychus pacificus* McG., and there is risk of serious mite damage when they are applied in July or August. Outbreaks could be prevented by the addition of sulphur on honeydew melons, and, as indicated in concurrent experiments [**40** 329], the use of other acaricides on varieties of melon that are injured by sulphur. In one test, a spray of Aramite (2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite) in early September following one of dieldrin in late August prevented the increase that occurred when dieldrin was used alone.

It is concluded from the two years' work that aldrin, dieldrin and heptachlor are of most value against *L. subpusilla*, other materials giving more effective control of the other pests. Dieldrin is probably the most promising. Since *L. subpusilla* is frequently checked by natural enemies [*cf.* **39** 344], treatment need not be begun until injury has become noticeable on the older centre leaves of the plants.

JEFFERSON (R. N.) & EADS (C. O.). **Control of Leaf Miners and other Insect Pests of Asters.**—*J. econ. Ent.* **45** no. 3 pp. 476–481, 9 refs. Menasha, Wis., 1952.

The Agromyzid, *Liriomyza langei* Frick [*cf. R.A.E.*, A **40** 65], is the most injurious insect pest of asters in the Los Angeles area of California, and various organic insecticides were tested in the field in 1948–50 for its control and incidentally that of the whiteflies, *Trialeurodes vaporariorum* (Westw.) and *Aleurodes spiraeoides* Quaint., and leafhoppers, of which the commonest are *Empoasca abrupta* DeL. and *Colladonus* (*Thamnotettix*) *montanus* (Van D.).

In 1948, sprays of 1·25 lb. toxaphene or 1·5 lb. chlordan as emulsion concentrates and 1 lb. chlordan or 0·24 lb. γ BHC (benzene hexachloride) in wettable powders per 100 U.S. gals., applied five times at fortnightly intervals, one of 0·25 lb. parathion in a wettable powder, applied only three times because of plant injury, and a dust containing 0·75 per cent. γ BHC, applied nine times at weekly intervals, all from 26th April, gave excellent control of *L. langei*, as measured by the numbers of mines in leaf samples, though parathion was significantly less effective than the other treatments. There were no significant differences between the toxaphene, chlordan and BHC sprays; the BHC dust was significantly less effective than the first two, but not than the BHC spray. The toxaphene and parathion sprays and the BHC dust were the only treatments effective against the leafhoppers, and parathion appeared to be the most effective treatment against the whiteflies, though the difference was significant only in the case of wettable chlordan.

In 1949, toxaphene, chlordan and lindane [at least 99 per cent. γ BHC], applied at 1, 1 and 0·25 lb. per 100 U.S. gals., respectively, three times at intervals of two weeks, gave no control of a severe outbreak of *L. langei* that occurred in August, but six applications of sprays of 1·25 lb. toxaphene and 1 or 2 lb. chlordan in emulsion concentrates per 100 U.S. gals., two of 0·15 lb. parathion followed by four of 0·24 lb. γ BHC (in wettable powders) per 100 U.S. gals. and 13 of a dust of 0·75 per cent. γ BHC or four of 1 per cent. parathion followed by nine of 10 per cent. toxaphene, all made between 15th August and 19th September, gave highly significant though not satisfactory control,

with no significant differences between treatments. The combined schedules and the toxaphene spray were effective against the leafhoppers, with no significant differences between them, and chlordan gave some control. There were no significant differences between treatments against the whiteflies, but all gave fair control and those that included parathion appeared to be the best.

In 1950, when dusts were applied seven times between 24th July and 29th August or four times between 15th August and 15th September, 1 per cent. parathion was significantly more effective than 2 per cent. EPN (O-ethyl O-p-nitrophenyl benzenethiophosphonate) against *L. langei* and the whiteflies and gave good control of both. In 1951, four applications of 0·65 lb. malathon (S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate) in a wettable powder and two of 0·375 lb. actual Systox (O-(2-(ethylmercapto) ethyl) O,O-diethyl thiophosphate) in an emulsifiable concentrate per 100 U.S. gals. were significantly more effective than one of 0·15 lb. parathion per 100 U.S. gals. against the leafhoppers ; infestation by *L. langei* was too low to show results, and differences were not significant against the whiteflies.

No injury to the plants was caused by chlordan, toxaphene, BHC, EPN or Systox. Sprays containing 0·15 lb. parathion per 100 U.S. gals. and 1 per cent. parathion dusts applied at more than 20 lb. per acre were sometimes injurious, and malathon caused injury at 0·65 lb. per 100 U.S. gals., but not at 0·49 lb. Parathion was used by some growers from 1949 onwards and proved so much more effective than other materials that it was in general use in 1951, with the result that damage by *L. langei* was slight.

DOWDEN (P. B.). **The Importance of coordinating applied Control and natural Control of Forest Insects.**—*J. econ. Ent.* **45** no. 3 pp. 481–483, 7 refs. Menasha, Wis., 1952.

The author points out that owing to control by many natural factors, most forest insects never become economically important and most of the serious pests remain at very low levels for long periods between outbreaks. When the application of control measures is contemplated, attempts should therefore be made to estimate the control to be expected from natural factors and to co-ordinate the two. Methods of doing this differ for different types of insects, but all involve an estimate of insect abundance, an evaluation of the main natural control factors operating, a decision as to when and where to apply control and a choice of the best measures, and these points are discussed with examples drawn from the United States. Most good silvicultural practices seem to favour the increase of natural control and are, therefore, probably preferable to other suppressive methods.

VINSON (E. B.) & KEARNS (C. W.). **Temperature and the Action of DDT on the American Roach.**—*J. econ. Ent.* **45** no. 3 pp. 484–496, 4 figs., 12 refs. Menasha, Wis., 1952.

An increase in susceptibility to DDT as a result of exposure at low temperatures has been recorded for *Blattella germanica* (L.) [*R.A.E.*, A **39** 122], several species of Diptera [B **38** 153 ; A **39** 53], *Tribolium castaneum* (Hbst.) [A **36** 380] and honey bees [A **38** 248]. Two explanations [A **37** 408 ; **39** 54] have been suggested for this, but neither fitted all the cases. Preliminary tests with females of the American cockroach [*Periplaneta americana* (L.)] showed that both topical and injected doses of DDT gave negative temperature coefficients of action. In this paper, the results are given of a

study to correlate the effects of temperature on the factors of penetration and detoxification of topical doses of DDT and the detoxification of injected doses with the type and magnitude of the temperature coefficients of action for the two methods of administration.

The following is substantially the authors' summary. In females of *P. americana,* both topical and injected doses of DDT in solution showed negative temperature coefficients of action at temperatures of 15 and 35°C. [59 and 95°F.]. The 5-day LD-50 values (median lethal doses) per cockroach were 5–10 mmg. at 15° and 75–100 mmg. at 35° for topically-applied DDT and 2–3 mmg. at 15° and 20–25 mmg. at 35°C. for injected DDT.

Chemical analyses correlated with the onset of symptoms of poisoning from topical applications of DDT showed that penetration of DDT is faster at 35° than at 15°C. However, the effect of temperature in changing the equilibrium between the opposing forces of penetration and detoxification does not account for the negative temperature coefficient of action of topical doses. The percentage metabolism of absorbed DDT was about the same at the two temperatures when equivalent dosages were compared. Consequently, in terms of absolute amounts, the unchanged DDT found in cockroaches kept at 35° was greater than that found in cockroaches kept at 15°; at the same time, the cockroaches kept at 35° appeared normal, while those at 15° were in the prostrate stage of poisoning. The larger amounts of unchanged DDT in apparently normal cockroaches at 35°C. became effective by causing prostration when the temperature was changed to 15°C.

Injected doses of DDT greater than the LD-50 dose at 15°C., but smaller than that at 35°C., caused prostration, within an hour, of cockroaches kept at 15°C., but did not seriously affect those kept at 35°C. Transfer of treated cockroaches from one temperature to the other resulted in reversal of poisoning symptoms ; cockroaches kept initially at 35°C. became prostrate on transfer to 15°C., and those kept initially at 15°C. recovered appearances of normality on transfer to 35°C. When treated cockroaches were kept at 15°C. for excessive periods before transfer, the symptoms could no longer be reversed ; the time required before prostration became irreversible decreased with increasing dosages of DDT.

The rate of metabolism of DDT within the first 12 hours after injection was determined by the amount of DDT injected and the detoxification potential (the maximal sum of factors present that interact in metabolising quantities of DDT) of the cockroach. The detoxification potential was not raised or lowered with increasing doses of DDT (from 8 mmg. to 20 mmg.) at 35°C., but was reduced by doses in excess of 8 mmg. at 15°C.

A correlation of the data on reversal of symptoms and the data on metabolism of DDT leads to the conclusion that the lower rate of metabolism of large doses of DDT at low temperatures is the result of the increased effectiveness of DDT in disrupting any physiological functions, including the processes responsible for the metabolism of DDT. The direct effect of temperature on the metabolism of injected DDT seems incidental to the intoxicating process. Thus, the negative temperature coefficient of action of DDT must be based on the effect of temperature on the intrinsic susceptibility of some physiological system to DDT.

The metabolites of DDT responding to the Schechter-Haller test formed a very small proportion of the total metabolised portion of both topical and injected doses of DDT. At both 15 and 35°C., the amounts of DDE [dichlorodiphenyldichloroethylene] and a product termed Metabolite X, recoverable from treated cockroaches, reached a maximum shortly after treatment, while the amounts of undetectable metabolites increased with time after treatment. This indicates that both DDE and Metabolite X may be intermediates formed in the degradation of DDT. The identity of Metabolite X and its relation to DDE and undetectable metabolites in the process of degradation remain

undetermined. It was also not established whether Metabolite X or undetectable metabolites play any significant part in the action of DDT.

STERNBURG (J.) & KEARNS (C. W.). **Metabolic Fate of DDT when applied to certain naturally tolerant Insects.**—*J. econ. Ent.* **45** no. 3 pp. 497–505, 8 refs. Menasha, Wis., 1952.

Since strains of the house-fly [*Musca domestica* L.] that are resistant to DDT have been shown to detoxify it by dehydrochlorination, with the formation of DDE (1,1-bis(p-chlorophenyl)-2,2-dichloroethylene) [*cf. R.A.E.*, B **39** 211, etc.] the metabolism and absorption of DDT by insects of four species that are normally resistant to it were studied, in an attempt to obtain additional information on resistance and possibly on the mode of action of DDT. DDD (1,1-bis(p-chlorophenyl)-2,2-dichloroethane) was similarly tested on two of them.

The following is based on the authors' summary of the results, which showed that all four insects could degrade DDT to non-toxic metabolites. Adults of *Melanoplus differentialis* (Thos.) degraded oral and topical dosages of DDT to DDE in the cuticle and digestive tract. When the DDT was ingested, large amounts appeared in the excreta unchanged, with smaller amounts of DDE. *M. femur-rubrum* (Deg.) behaved similarly. Larvae of *Epilachna varivestis* Muls. degraded oral and topical dosages of DDT to DDE and further converted DDE to an unidentified compound or compounds; neither DDT nor DDE was excreted. Larvae of *Eulia* (*Argyrotaenia*) *velutinana* (Wlk.) degraded topical and oral dosages of DDT to DDE, but when DDT was ingested, some of it was excreted, together with DDE. Larvae of *Epilachna*, which are highly resistant to DDD, degraded it to form dehydrochlorinated DDD and further degraded this to an unidentified product. DDD exerted some repellency against larvae of *Eulia velutinana*, to which it is more toxic than DDT, and this prevented them from feeding on deposits of it. When treated topically they did not degrade the compound rapidly, and only traces of a metabolite could be found, whereas DDD was recovered from the tissues.

STERNBURG (J.) & KEARNS (C. W.). **Chromatographic Separation of DDT and some of its known and possible Degradation Products.**—*J. econ. Ent.* **45** no. 3 pp. 505–509, 5 refs. Menasha, Wis., 1952.

By the Schechter-Haller colorimetric method for the quantitative determination of DDT and its analogues [*cf. R.A.E.*, A **35** 412], p,p'DDT yields an intense blue colour, whereas various analogues, either known or theoretically possible as metabolites, yield red colours, with the result that they cannot be differentiated from one another. A method of separating them by the use of a succession of solvents is described in this paper, the compounds considered being DDE (1,1-bis(p-chlorophenyl)-2,2-dichloroethylene), DDA [bis(p-chlorophenyl) acetic acid], 4,4'-dichlorobenzophenone, 4,4'-dichlorobenzhydrol, bis-p-chlorophenyl methane and p-chlorobenzoic acid. The last four of these are theoretically possible as metabolites but have not been found in insect tissues.

DDE appears to be the principal metabolite of DDT produced by insects, but others are known, of which one of unknown composition also produces a red colour in the test. A metabolite behaving like dichlorobenzhydrol has been isolated from *Sarcophaga crassipalpis* Macq. and *Periplaneta americana* (L.), but not specifically identified owing to the presence of interfering materials from insect tissue. The conversion of DDT to DDA, the principal metabolic end product of DDT in vertebrates, appears to be of minor importance in insects, the only report of its presence, in a DDT-resistant strain of *Musca domestica* L. [B **38** 209], being probably due to experimental error.

The procedures described have been found adaptable to the study of DDT metabolism in *M. domestica*, *Blattella germanica* (L.), *P. americana*, *Melanoplus differentialis* (Thos.), *M. femur-rubrum* (Deg.), *Epilachna varivestis* Muls., *Eulia* (*Argyrotaenia*) *velutinana* (Wlk.) and *S. crassipalpis*. DDT and its metabolites are extracted with diethyl ether from up to 2 gm. ground insect tissue [*cf.* B **38** 209]. If the presence of DDA or p-chlorobenzoic acid is suspected, the sample is first acidified and alkaline extraction is used to remove them. They can then be determined by the Schechter-Haller method. However, if it can be shown that they are absent from a given species of insect, this step may be omitted in subsequent experiments with that species. The remaining solvent is washed to remove traces of alkali, which would interfere with later determinations, and evaporated from the insect extractive. The residue is taken up in petroleum ether and introduced into a column of activated alumina, and more petroleum ether is passed through the column and collected in a flask. This eluate will contain any DDE present. Carbon tetrachloride is then passed through the column into another flask to collect any DDT, followed by benzene to collect 4,4′-dichlorobenzophenone, and diethyl ether or acetone to collect 4,4′-dichlorobenzhydrol. The solvents are carefully evaporated from the four eluates, and analyses made by the Schechter-Haller method. Bis-p-chlorophenyl methane, if present, will appear with DDE in the petroleum-ether eluate, but if the residue is refluxed in ethylene glycol and potassium hydroxide to convert DDE to DDA and the reaction mixture extracted with diethyl ether, the methane can be separated from the water-soluble potassium salt of DDA, and both can be determined by the Schechter-Haller method; this step may ordinarily be omitted.

Fat from 2 gm. insect tissue does not interfere with the separation, and DDT and DDE are isolated almost free of fat. Recoveries of small quantities of these range from 90 to 100 per cent., and those of 4,4′-dichlorobenzophenone and 4,4′-dichlorobenzhydrol, though occasionally low, are generally better than 90 per cent.

Gaines (J. C.), King (C. E.) & Fuller (F. M.). **Spider Mite Control on Cotton.**—*J. econ. Ent.* **45** no. 3 pp. 523–526, 7 refs. Menasha, Wis., 1952.

An account is given of further tests at College Station, Texas, of phosphorus and sulphur compounds that could be added for the control of the mites, *Tetranychus bimaculatus* Harvey and *Septanychus texazona* McG., to emulsion sprays of organic compounds applied against insects on cotton [*cf.* *R.A.E.*, A **39** 166; **40** 172].

In sprays applied in the laboratory, Aramite (2-chloroethyl 2-(p-tert.-butylphenoxy)-1-methylethyl sulphite) was more toxic than Ovotran (p-chlorophenyl p-chlorobenzenesulphonate), Sulphenone (p-chlorophenyl phenyl sulphone) or Genite-923 (2,4-dichlorophenyl benzenesulphonate), and each of these was more toxic to *S. texazona* than to *T. bimaculatus*, whereas EPN [O-ethyl O-p-nitrophenyl benzenethiophosphonate] and parathion were more nearly equal in effectiveness against both species, parathion being the more toxic. Sulphur dust used in excessive quantities failed to control *T. bimaculatus*. In the greenhouse, where heavily infested potted cotton plants were sprayed and subsequently kept in close proximity to other heavily infested plants, parathion at 0·06 lb. per acre gave high mortality for a week, as compared with 15 and 20–25 days for Systox [O-(2-(ethylmercapto)ethyl) O,O-diethyl thiophosphate] at 0·25 and 0·5 lb., respectively. Systox acted systemically and by contact. When applied as coarse low-volume sprays, 0·3 lb. Aramite and 2 lb. Ovotran, Sulphenone or Genite per acre were all ineffective against the eggs of either mite, but in the case of *S. texazona*, Sulphenone and Ovotran killed about half the young mites as they hatched, on the fourth and fifth days after application.

Field tests were carried out against *S. texazona* on cotton in 1951 with emulsion sprays applied by aeroplane at about 2 U.S. gals. per acre or by power sprayer at about 7·5 U.S. gals. per acre and with dusts applied by aeroplane or by hand. About 0·4 lb. Aramite per acre in sprays or dusts gave control comparable with that from 2 lb. Ovotran or Sulphenone in sprays or dusts or Genite in sprays or 15 lb. sulphur dust. The compounds appeared to be effective for 6–7 days. None gave complete control, and the residual toxicity was too short to kill all the mites hatching from the eggs. Parathion and malathon (S-(1,2-dicarbethoxyethyl) O,O-dimethyl dithiophosphate) in sprays and dusts and TEPP [tetraethyl pyrophosphate] and EPN in sprays gave effective control at about 0·25 lb. per acre. TEPP showed inferior residual toxicity, and several applications were required for effective control. Systox and schradan (octamethyl pyrophosphoramide) (another systemic material), applied at 0·5 lb. per acre by a tractor sprayer, prevented mites from developing for about four weeks ; Systox proved an excellent contact poison at that high rate of application.

PELLEGRINI jr. (J. P.), MILLER (A. C.) & SHARPLESS (R. V.). **Biosynthesis of radioactive Pyrethrins using $C^{14}O_2$.**—*J. econ. Ent.* **45** no. 3 pp. 532–536, 3 figs., 6 refs. Menasha, Wis., 1952.

The authors describe a method of obtaining radioactive pyrethrins by growing pyrethrum plants (*Chrysanthemum cinerariaefolium*) for a prolonged period in an atmosphere containing radioactive carbon dioxide ($C^{14}O_2$) and isolating and purifying the pyrethrins from the C^{14}-labelled flowers. Since studies on the formation of pyrethrins in field-grown plants showed that the percentage in the flowers increases as these develop and reaches a maximum in the mature flowers, a period of 6–7 weeks before harvest was considered adequate to ensure labelling of pyrethrins precursors and to obtain a final product labelled at random and of specific radioactivity sufficiently high for tracer studies. In a preliminary test, treatment for 18 hours 4–10 days before maturation proved inadequate.

In March 1951, ten field-grown crowns of *C. cinerariaefolium* with no stem growth were transplanted to a field plot 5 ft. square and covered with a gas-tight greenhouse, which was fitted with a collapsible breather-bag of about 12 cu. ft. capacity at one end, to ensure a constant pressure of about one atmosphere, and gas inlet and outlet lines, wiring for temperature and humidity control, a fan and refrigerating equipment at the other. Six 150-watt spot lamps were installed externally along the sides to maintain utilisation of carbon dioxide in cloudy weather. A mixture of $C^{14}O_2$ and normal carbon dioxide ($C^{12}O_2$) was generated from a mixture of radioactive and normal barium carbonates ($BaC^{14}O_3$ and $BaC^{12}O_3$) and pumped into the greenhouse. During the daytime, the temperature averaged 75°F., the relative humidity 64 per cent., and the concentration of carbon dioxide 0·11 per cent. ; these factors were not controlled at night. $C^{14}O_2$ was administered from 30th April, and the plants developed normally, though faster than those in the field owing to the higher temperature, and were harvested 46–56 days later. A total of 45 millicuries of radioactive barium carbonate was used.

The harvested material was oven-dried at 125°F. for eight hours and then air-dried at room temperature for 72 hours, and yielded 62·2 gm. dry pyrethrum flowers. Determinations of radioactivity at various stages showed 5,720, 9,000 and 34,100 counts per minute for the fresh, dried and ground flowers, respectively. About 400 mg. pure pyrethrins was extracted from the flowers, and was dissolved in n-hexane and stored in the dark at 0°C. [32°F.]. Tests showed that the pyrethrins had the expected insecticidal activity against house-flies [*Musca domestica* L.] and cockroaches and that they were labelled with C^{14}

in both alcohol and acid portions of the molecules at levels high enough for qualitative and quantitative determinations.

Detailed observations made throughout the work, precautions taken and improvements that could be made in the method are discussed.

WEAVER (N.). **The Toxicity of organic Insecticides to Honey Bees.**—*J. econ. Ent.* **45** no. 3 pp. 537–538, 1 graph, 2 refs. Menasha, Wis., 1952.

In further tests in Texas in 1951 in which colonies of honey bees were confined in cages 36 ft. long over two rows of cotton plants, dusts of 3 per cent. γ BHC (benzene hexachloride) with 5 per cent. DDT, or of 10 per cent. DDT or chlordan or 20 per cent. toxaphene, all with 40 per cent. sulphur, and 2·5 per cent. dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] without it, were applied at 5–20 lb. per acre. All the materials but chlordan were more toxic than in 1949 or 1950 [*cf. R.A.E.*, A **39** 14, 345], but there were no significant differences in any material applied at low or high temperatures in the same year. Dieldrin caused high mortalities in spite of a pronounced repellent effect, and this was probably partly due to contamination of nectar carried into the hive. Six applications killed 54·6 per cent. of the bees in the nucleus. Both chlordan and the mixture of BHC and DDT were less repellent in 1951 than in 1950; they caused 19·2 and 6·6 per cent. mortality, respectively, during the season. DDT and toxaphene showed little repellency and caused 13·6 and 11·6 per cent. total mortality.

In limited tests, sprays of toxaphene and of toxaphene with DDT (2 : 1) applied to cotton at 2 lb. active ingredient per acre were slightly less toxic than the toxaphene and DDT dusts, respectively, and sprays of dieldrin and aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] at 0·25 lb. per acre were slightly less toxic than the dieldrin dust and, like it, caused greater mortality on the second than on the first day after application. Sprays were considerably more toxic than dusts when applied directly to bees, and only a little spray drifting into a nucleus produced high mortality; this was particularly true of dieldrin and aldrin.

BREAKEY (E. P.) & GOULD (C. J.). **Wireworm Control on Wedgewood Iris.**—*J. econ. Ent.* **45** no. 3 p. 538. Menasha, Wis., 1952.

In order to determine whether Wedgewood iris bulbs can be protected against wireworm injury by treating them with an insecticide before planting, bulbs of various sizes were dipped for ten minutes in suspensions of fungicide or insecticide on 16th October 1950 and planted near McMillan, Washington, on the same day in soil infested with wireworms, the species injurious locally being *Limonius canus* Lec. They were removed from the soil as soon as mature, allowed to cure and cleaned for inspection. The mean numbers injured in samples averaging 85–90 bulbs each were about 49 and 40 after no treatment and treatment with the fungicide thiram (50 per cent. tetramethyl thiuram disulphide) at a concentration of 1 : 75, about 12, 31 and 17 after treatment with the fungicide with BHC (benzene hexachloride) at 1 : 200, DDT at 1 : 80 and dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] at 1 : 200, respectively, and about 15 after treatment with BHC in water (1 : 200). All treatments but thiram alone gave highly significant protection.

KLOSTERMEYER (E. C.). **Control of Red-backed Cutworm with Toxaphene and Methoxychlor Dusts.**—*J. econ. Ent.* **45** no. 3 pp. 539, 3 refs. Menasha, Wis., 1952.

An outbreak of *Euxoa ochrogaster* (Gn.), which damages crops in irrigated central Washington nearly every spring, was reported on lucerne on 1st May 1951, and various insecticides were applied in dusts at 30 lb. per acre on 7th May. The numbers of dead and dying larvae per 36 sq. ft. on the surface of the soil 36 hours and (in brackets) two weeks after treatment were 1 (9) for no treatment, 4 (43) and 6 (101) for 1 per cent. aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] and dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene], respectively, 21 (152) for 5 per cent. chlordan and 31 (61), 249 (452) and 366 (1,271) for 10 per cent. DDT, methoxy-DDT (methoxychlor) and toxaphene, respectively. The differences among the mean numbers of living larvae per sq. ft. in the top two inches of soil one week after treatment were not significant, but there were fewest in plots treated with toxaphene and methoxy-DDT. When affected larvae were caged in the laboratory, all those from the plots treated with toxaphene, methoxy-DDT, chlordan and dieldrin were dead after five days, but only half of those exposed to DDT and aldrin died.

Toxaphene was the best material tested, giving excellent and rapid control, and methoxy-DDT, which had a rapid initial effect but killed fewer larvae during the period of observation, should be useful where the application of materials of greater toxicity to mammals is undesirable. The other materials were of little value.

FULTON (R. A.), GELARDO (R. P.) & SULLIVAN (W. N.). **Relative Efficiency of Methods of applying Lindane in enclosed Spaces.**—*J. econ. Ent.* **45** no. 3 pp. 540–541, 2 refs. Menasha, Wis., 1952.

As it has been shown that the vapour from an aerosol or spray deposit of lindane [at least 99 per cent. γ benzene hexachloride] is toxic to insects in enclosed spaces [*R.A.E.*, A **38** 508], experiments were made in 1951 to determine the concentration of vapour built up following application of lindane by four different methods. Four airtight chambers, each with a capacity of 3,000 cu. ft., were used. The walls and ceiling of one were sprayed once at 25 mg. lindane per sq. ft. with a suspension made from a water-dispersible powder containing 25 per cent. lindane. The second was provided with an air-circulating device [B **39** 140] by means of which the air was blown continuously through a Fiberglass filter that had been sprayed with an acetone solution of lindane. The third was treated with an electrically heated vaporiser set to operate continuously and maintain the temperature of the lindane at 113–116°C. The fourth was treated weekly with a solution of lindane propelled by carbon dioxide at 300 mg. lindane per 1,000 cu. ft. The composition of the solution was 1 per cent. lindane, 50 per cent. cyclohexanone, 45 per cent. acetone and 4 per cent. carbon dioxide.

Air was analysed and mortality of house-flies (*Musca domestica* L.) exposed to the vapour was noted periodically. The quantities of lindane in the air in mg. per 1,000 cu. ft. 1 hour and 1, 6, 15 and 21 days after treatment and (in brackets) the percentage mortalities of house-flies in 60 minutes were 4·8 (99), 21·8 (97), 7·4 (99), 2·4 (27) and 0·96 (28) with the suspension spray; 4·8 (100), 11·9 (100), 17 (100), undetermined (99) and 11·9 (76) with the screen and fan; and 4·8 (51), 19·5 (32), 5·9 (100), 0·96 (20) and an undetermined amount (9) with the vaporiser. With the solution, there was 11·9 mg. lindane per 1,000 cu. ft. after 1 hour and 5 days, an undetermined amount after 6 days and 1·4 mg. after 8 days, and percentage mortalities after these periods were 100,

31, 64 and 42. Despite the small amount applied, the solution left a deposit on the walls and ceiling that was effective for 5–8 days. The deposit from the suspension was visible for about two weeks, after which it was obscured by dust and vapour concentration fell. The treated screen also became coated with dust after a short time, and for maximum efficiency should be protected by a dust filter.

BECKHAM (C. M.). **A Parasite of the Vegetable Weevil.**—*J. econ. Ent.* **45** no. 3 p. 541, 4 refs. Menasha, Wis., 1952.

Dissection of adults of *Listroderes obliquus* Gylh. in Georgia in January 1951 revealed the presence of endoparasitic Dipterous larvae, and adults reared from them were identified as *Clistomorpha* (*Hyalomyodes*) *triangulifera* (Lw.). Further investigations showed 19·62 per cent. parasitism among 107 adults of *L. obliquus* collected in January, none among 29 collected in October and 12·55 per cent. among 462 collected in January–February 1952. The larvae were found in the abdomen and occurred singly except in two hosts, which contained two each. They left the hosts before pupating, and the pupal stage lasted 17–22 days in the laboratory. No parasites were found in a few larvae of *Listroderes* dissected in January 1951. No insect parasites of *L. obliquus* have previously been found in the United States.

RICHARDSON (H. H.). **Ethylene Dibromide Fumigation of Mangoes and Almendras infested with *Anastrepha* Fruit Flies.**—*J. econ. Ent.* **45** no. 3 pp. 541–543, 1 ref. Menasha, Wis., 1952.

In tests carried out at San Juan, Porto Rico, with ethylene dibromide, vaporised by heat in a 300 cu. ft. steel chamber provided with a fan, fumigation with 2–6 oz. per 1,000 cu. ft. for two hours killed all larvae and pupae of *Anastrepha mombinpraeoptans* Seín in mangos and *A. suspensa* (Lw.) in nuts of almendra [*Terminalia catappa*] at temperatures of 85–87°F. The load was small in most tests as compared with the capacity of the chamber. Some larvae of *A. mombinpraeoptans* exposed to a dosage of 1 oz. remained moribund for 3–4 days, but died by the fifth day, indicating that this is near the low limit for effectiveness. Mortality was also complete in fruit that was precooled to about 50°F. for 1–2 days before fumigation and kept at this temperature for five days after it, to simulate cold-storage conditions during shipment to New York, and penetration into commercially packed crates, sacks and open cans was satisfactory.

In two tests, about 45 and 55 per cent. of the space was occupied, and dosages of 4–6 oz. ethylene dibromide gave complete kill, though not till the sixth day at the lower dosage, which is apparently near the limit of complete efficiency for large loads. The 6-oz. dosage appears more practical for large-scale use at temperatures near 85°F.

Little detrimental effect on the flavour of several varieties of mango could be detected at dosages of 2–6 oz. Some spoilage occurred when commercially packed ripe mangos were kept at temperatures near 50°F. for five days after fumigation, but similar losses occurred in untreated fruit. The spoilage was least in green fruits and these appear to be the most suitable for shipment in cold storage.

EDEN (W. G.). **Effect of Husk Cover of Corn on Rice Weevil Damage in Alabama.**—*J. econ. Ent.* **45** no. 3 pp. 543–544, 12 refs. Menasha, Wis., 1952.

Varieties of maize with good husk cover have been widely recommended for reducing injury by the rice weevil [*Calandra oryzae* (L.)] both in the field

[*cf. R.A.E.*, A **23** 43; **29** 185] and in the stored ears [*cf.* **22** 258], but no method of sampling has hitherto been available for assessing the proportion of grains in which larvae are actually developing. The relation between the amount of the maize ear covered by the husk and the degree of infestation was therefore re-examined in Alabama in 1949–50, the acid fuchsin stain method being used to measure the latter. The degree of husk covering was ascertained on 29 varieties and hybrids of maize, the ears were harvested when mature, and half of each replicate of each variety was examined immediately and the other half after storage for eight months. Samples of 500 kernels from each variety at each date showed least damage at harvest in maize with well-covered ears and heaviest damage in poorly covered ears, statistical analysis showing a significant inverse relation between husk cover and weevil damage. The relation was the same, though less marked, after storage.

SHELFORD (V. E.). **Termite Treatment with aqueous Solution of Chlordane.**—*J. econ. Ent.* **45** no. 3 p. 544. Menasha, Wis., 1952.

In tests in 1951 of soil near the foundations of a house in Illinois that had been treated with 1 per cent. chlordan in September 1947 for the control of termites [*R.A.E.*, A **38** 251], the onset of the paralysis of the test termites occurred after a more uniform time and toxicity appeared to be a little greater than at the end of three years [**40** 178]. This is thought to have been due to a difference in the condition of the insects.

CROWELL (H. H.). **Cabbage Seedpod Weevil Control with Parathion.**—*J. econ. Ent.* **45** no. 3 pp. 545–546. Menasha, Wis., 1952.

Ceuthorrhynchus assimilis (Payk.), which has been established in Oregon since 1936, has not reached such high populations in the Willamette Valley as in some neighbouring States, possibly owing to the prevalence of wild turnip (*Brassica campestris*) and a high rate of parasitism. Attempts to correlate adult populations in cabbage fields with the resultant seed loss caused by the larvae showed that weevil numbers of about 0·05–3 per sweep of an insect net resulted in seed losses of 0·25–16 per cent., and it is tentatively concluded that a weevil population of 0·4 or more per sweep at full bloom (mid-May) results in 10–16 per cent. loss of cabbage seed if no control measures are applied. BHC (benzene hexachloride) is effective against the adults [*cf. R.A.E.*, A **40** 111], and preliminary tests in 1948 showed that a dust of 2 per cent. parathion was still more promising and that both it and BHC affected the larvae within the pods. Plots of seed cabbage were therefore given two applications of 2 per cent. parathion dust, one of which was washed off by rain, in May 1949 and one in mid-June 1950, when flowering was complete. Seed losses were estimated at about 1 and 1·3 per cent., respectively, instead of at least 10 per cent., as indicated by populations of 0·44–2·1 weevils per sweep at full bloom.

In insectary tests, comparison of the numbers of larvae in turnip pods showed 70 per cent. moribund and 80 and 96 per cent. dead on the second, fifth and seventh days after the sprigs were dusted with 2 per cent. parathion, whereas 100, 100 and 96 per cent., respectively, were alive in untreated ones. Egg ratios of 1·4 : 1, 3 : 1 and 13 : 1 in treated and untreated pods on the three days suggested that parathion either kills the eggs or greatly delays their hatching. On cabbage, which usually has only one larva per pod in the Valley, all were dead in treated and all alive in untreated pods seven days after dusting.

In the field, turnips dusted once with 2 per cent. parathion at 40 lb. per acre when flowering was complete showed 64 per cent. mortality of larvae in the pods one week later, as compared with 16 per cent. in untreated pods. Parasites, principally *Trichomalus fasciatus* Thoms. [*cf.* **38** 22], had attacked 48 per cent. of

the larvae in treated pods and 20 per cent. in untreated ones, but the difference may have been due to sampling error. These results indicate that dusting with 2 per cent. parathion after bloom may satisfactorily prevent seed loss in the Willamette Valley, and such treatment would not seriously affect populations of honey bees. Parathion has the advantage over BHC of not contaminating the soil for food crops, but is dangerous to use.

Snapp (O. I.). **Treatment of Peach Nursery Stock to prevent Infestation by Peach Tree Borer.**—*J. econ. Ent.* **45** no. 3 p. 546. Menasha, Wis., 1952.

Although *Aegeria* (*Sanninoidea*) *exitiosa* Say can be controlled after the larvae have entered peach nursery stock, severely injured material cannot be sold, and tests were therefore made in Georgia in 1950 to develop a treatment that would prevent attack. Sprays of 8 lb. 6 per cent. wettable γ BHC (benzene hexachloride) or 50 per cent. wettable DDT per 100 U.S. gals. were applied to the trunks at a pressure of 300–350 lb. per sq. in. on 2nd August, 1st September and 2nd October and the plants were dug on 30th–31st October. Examination showed that the percentages infested were 5 for BHC, 3 for DDT and 22·6 for no treatment.

Snapp (O. I.). **Benzene Hexachloride and DDT Sprays for Peach Tree Borer Control.**—*J. econ. Ent.* **45** no. 3 p. 547. Menasha, Wis., 1952.

In experiments in Georgia on the control of *Aegeria* (*Sanninoidea*) *exitiosa* Say in peach trees 4–7 years old, sprays containing 8 lb. 6 per cent. wettable γ BHC (benzene hexachloride) or 50 per cent. wettable DDT per 100 U.S. gals. were applied on 15th–16th August and 1st September 1949, on these dates and 15th September 1949 or on 1st August, 5th–11th September and 10th October 1950. The trees were examined between 9th and 24th May 1950 or 23rd April and 10th May 1951, and the numbers of living larvae per tree averaged 0·1–13·2 and 0–6·4 after two and three applications of BHC, respectively, and 0·4–10·2 and 0·6–11·1 after two and three of DDT in 1949 and 0·1–1·1 and 0–1·3 for BHC and DDT in 1950, as compared with 6·1–20·9 for no treatment in the first year and 3·8–11·5 in the second.

Merrill jr. (L. G.). **Reduction of Wireworm Damage to Potatoes.**—*J. econ. Ent.* **45** no. 3 pp. 548–549. Menasha, Wis., 1952.

Wireworms (*Agriotes mancus* (Say) and *Melanotus* spp.) are injurious to potato tubers in Michigan, particularly those growing in newly broken ground or ground on which a suitable crop rotation has not been practised, and are difficult to control. Technical BHC (benzene hexachloride) was effective, but tainted the tubers and has not been adopted by growers. In a test in 1950, a recently planted field was sprayed with parathion at 4 lb. per acre and the surface cultivated to a depth of 4 ins. The results were disappointing, 47·9 per cent. of the tubers from the treated area being damaged by wireworm, as compared with 71 per cent. from an untreated area. It was not known whether this was due to too low a rate of application or to excessive volatilisation of the parathion before the soil was cultivated. There was no effect on the flavour of the tubers. In 1951, various insecticides were applied in dusts shaken from a sack to a similar newly planted field and the surface cultivated immediately to a depth of 4 ins. Satisfactory control (less than 5 per cent. damaged tubers) was given by aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene], dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] and lindane [at least 99 per cent. γ

BHC] at 1·5 lb. per acre, and by parathion and EPN-300 [O-ethyl O-p-nitrophenyl benzenethiophosphonate] at 4 lb. per acre, all in pyrophyllite, and by chlordan at 5 lb. per acre applied in a commercial mixture with a fertiliser ; damage averaged 31·7 per cent. for no treatment. When samples of tubers from some of the plots receiving the maximum dosages, including lindane at 6 lb. per acre and EPN-300 at 16 lb., were rated for general appearance, colour, odour, flavour and texture, all proved acceptable, but there were indications of slight inferiority in flavour for chlordan at 5 lb. and aldrin at 6 lb. per acre. Parathion and EPN-300 are considered promising, since they would not increase the chlorinated-hydrocarbon residues in the soil resulting from the use of DDT sprays on the foliage.

HANNA (R. L.) & GAINES (J. C.). **Evaluation of Dusting Schedules for Control of Cotton Insects.**—*J. econ. Ent.* **45** no. 3 pp. 549–550, 2 refs. Menasha, Wis., 1952.

In a further factorial experiment on the control of cotton pests in Texas [*cf. R.A.E.*, A **30** 252 ; **37** 460], plots of cotton plants received five early applications of 20 per cent. toxaphene dust at about 10 lb. per acre between 5th May and 7th June, three late applications of various dusts at 15 lb. per acre between 12th and 23rd July, or both ; 20 per cent. toxaphene and mixtures of 2·5 per cent. aldrin [1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-1,4,5,8-diendomethanonaphthalene] or dieldrin [1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-diendomethanonaphthalene] with 5 per cent. DDT were tested in the late treatments, and all dusts contained 40 per cent. sulphur.

Statistical analysis of the results, which are given in a table, showed that control of thrips was adequate on all plots treated early in the season. Infestation by *Anthonomus grandis* Boh. was unimportant throughout the test, and that by *Heliothis armigera* (Hb.) was not severe, but was better controlled on plots treated late in the season. The sulphur prevented damaging increases of the mite, *Septanychus texazona* McG., but plots that received only early treatment had four times as many per sample of terminals as those receiving both early and late treatment. Mite infestation was intermediate on untreated plots and those receiving late treatment only.

The cotton was picked on 7th August and 11th September. There were no significant differences between yields, probably owing to extremely dry, hot weather and light damage by *Anthonomus* and *Heliothis*, but significantly more of the total yield was harvested at the first picking from plots that received early treatment ; this may have been due principally to early control of thrips.

WALLACE (M. M. H.) & MAHON (J. A.). **Webworm Damage to Pastures in the South-west of Western Australia.**—*J. Aust. Inst. agric. Sci.* **18** no. 2 pp. 91–94, 1 ref. Sydney, 1952.

JENKINS (C. F. H.) & FORTE (P. N.). **The Webworm (*Talis pedionoma* Meyr.) ?**—*J. Dep. Agric. W. Aust.* (3) **1** no. 2 pp. 187–193, 6 figs., 2 refs. Perth, W.A., 1952.

It is stated in the first of these two papers that during the winters of 1949 and 1950, grasses in sown pastures in the Katanning district and wheat crops in many areas in the southwest of Western Australia were severely damaged by larvae tentatively associated with Crambine moths identified as *Talis pedionoma* Meyr. Recent observations have indicated that several species of similar habits are involved, though *T. pedionoma* appears to be the main one ; earlier attacks on wheat by similar larvae were attributed to *Sclerobia tritalis* (Wlk.)

[*R.A.E.*, A **21** 29]. The larvae had not been numerous in 1947 or 1948, and though large numbers of adults were present in the autumn of 1951, the resulting infestation was low. The adults are normally present from the first week in April to the first or second week in May ; numbers reach a peak about the second week of April, and remain high for about three weeks. The females are thought to oviposit among dry grass near the ground. The larvae construct short, vertical, silk-lined tunnels, usually in the soil, but occasionally in the débris on it, and feed by cutting off grass blades and gradually drawing them into the tunnels. Species of *Vulpia*, *Hordeum* and *Bromus* are attacked, but *Lolium* spp. appear to be resistant. Feeding is usually completed by mid-August, but larvae have been found in pastures as late as October.

The effect of the larvae on the composition of a mixed pasture including subterranean clover [*Trifolium subterraneum*] was investigated in plots that received a dressing of superphosphate alone or mixed with 0·25, 0·5 or 1 per cent. DDT on 25th March, 14th April or 6th May 1949 at the rate of 90 lb. per acre. The DDT gave virtually complete control of the larvae in each case, and treatment with it resulted in greatly increased yields of grasses, reduced yields of subterranean clover, probably owing to competition, and consistent, but not significant, reductions in the yield of capeweed [*Cryptostemma calendulaceum*]. The larvae reduced the yield of grasses and the total yield in untreated plots by 85 and over 50 per cent., respectively. DDT was sufficiently persistent at 1 per cent. to give complete control of the larvae during the following season, and also gave some control at 0·5 per cent., though infestation was fairly heavy. Comparison of the plots that had received 0·25 and 1 per cent. DDT showed that the yield of grasses and the total yield had been reduced by over 80 and 17 per cent., respectively, on the former. Yields of clover were higher than in 1949, apparently owing to favourable seasonal conditions, and the yield of capeweed in the control plots was higher in 1950 than in 1949, probably because the reduction in grasses in the latter year favoured establishment, but possibly also because the greater amount of clover and the deposition of excreta by the larvae in 1949 raised the nitrogenous content of the soil. It was again lower in the treated than in the untreated plots in 1950. Mixtures of DDT and superphosphate at the experimental concentrations applied on a large scale in late summer to infested grazed pastures gave good control ; the reductions in grass yield and total yield due to attack were found to be 88 and 40 per cent., respectively. In view of the considerable extent to which infestation affects the growth and composition of pastures, it may sometimes be practicable to apply control measures ; DDT appears to be suitable, since only small quantities are required and it can be applied with routine applications of fertiliser.

In the second paper, the authors give a more popular account of the bionomics and importance of the species concerned and state that the moths found associated with *T. pedionoma* included *T. panteucha* Meyr. Clean fallow is not attractive for oviposition, and the reduction in fallow cropping in many areas in recent years has been the cause of the increased importance of the larvae as pests of cereals. Both barley and rye are attacked and losses of wheat in newly ploughed grassland are sometimes serious ; oats are not damaged. The first sign of infestation is the appearance of thin patches among the young plants, and these later become completely bare and increase in area. Investigations on control by cultural methods indicated that the best protection is given by planting on clean fallow, that losses are less likely if sowing is delayed for 2–3 weeks after ploughing, and that rolling, harrowing and cultivating are of no appreciable value. A 2 per cent. DDT dust applied at 28 lb. per acre to infested wheat in July 1950 gave high mortality of the larvae, and a spray of 4–32 oz. DDT at 10 gals. per acre applied to natural grass pasture in 1951 almost entirely eliminated a population of about half a million larvae per acre.

MILLER (L. W.) & MARTYN (E. J.). **A sampling Technique for underground Grass Grubs.**—*J. Aust. Inst. agric. Sci.* **18** no. 2 pp. 110–111, 2 figs. Sydney, 1952.

During work on the control of *Oncopera intricata* Wlk. in turf in Tasmania, it became necessary to estimate the density of the larvae in the soil. This was done by removing the turf and soil to a depth of one inch over a sampling area one foot square, loosely plugging the openings of the tunnels made by the larvae with soil, covering the area with a metal plate, and counting the number of holes opened after 24 hours. Good agreement was found between this number and that obtained by digging out the soil and counting the larvae present.

JENKINS (C. F. H.). **A new Insect Pest in W.A. Oriental Fruit Moth** (*Cydia molesta* **Busck**).—*J. Dep. Agric. W. Aust.* (3) **1** no. 3 pp. 349–351, 4 figs. Perth, W.A., 1952.

Cydia molesta (Busck), which has been established for many years in eastern Australia, was observed in Western Australia for the first time in 1952. Brief descriptions are given of all stages, together with notes on the damage it causes to peach and the control measures found effective elsewhere.

HOGAN (T. W.). **Aerial Spraying of Locusts : Campaign in north-western Victoria.**—*J. Dep. Agric. Vict.* **50** pt. 3 pp. 112–114, 2 figs., 1 map. Melbourne, 1952.

During September and October 1950, eggs of *Chortoicetes terminifera* (Wlk.) were reported to be hatching on both sides of the River Murray, in north-western Victoria and south-eastern New South Wales. Poison baits were used in October, but since it seemed likely that adults would migrate to the large areas of cereal and vegetable crops and irrigated pastures lower down the river in Victoria, it was decided to conduct an aerial spraying campaign against them. In late November, locusts that had reached a point farther down the river in New South Wales formed dense swarms and began to cross into Victoria. Spraying operations were begun on 2nd December and were carried out from two Dakota DC 3 aeroplanes fitted with spray bars and tanks. The spray consisted of a solution of 1·3 per cent. γ BHC (benzene hexachloride) in a mixture of diesel fuel oil and Sovacide (an involatile aromatic petroleum fraction in which BHC is highly soluble), and it was applied at the rate of 2 gals. per acre. The course was indicated by means of smoke generators, flags and radio communication, and the aircraft flew at heights of 50–100 ft., generally across wind, except at high wind speeds, when they flew into the wind ; a swathe width of 88 yards was used. When the spray had been applied to the infested pastures and along the river itself, some 8,000 acres in New South Wales were also treated, making a total of 14,000 acres ; the area was effectively cleared of locusts, and the crops and pastures were protected from serious damage.

Both in this campaign and in an earlier one [*R.A.E.*, A **38** 480], a tendency was noticed for the locusts to move out of a sprayed area, the distance they flew being inversely related to the dosage of BHC. It is assumed that those that receive a sub-lethal dose from spray drift also move away and that they may cover a considerable distance. In order to destroy an infestation, it is therefore necessary to concentrate treatments over a relatively short period, but the application of BHC at low concentrations might sometimes be of value to induce migration or keep the locusts in flight. The costs of the campaign, which are discussed, were low in view of the value of the crops protected.

GADD (C. H.). **Studies of Shot-hole Borer of Tea. IV. Life Cycle of the Beetle.**—*Tea Quart.* **20** pt. 2 pp. 61–65, 1 pl., 5 refs. Talawakelle, 1949. **V. Borer Population.**—*T.c.* pp. 66–76, 3 refs.

In the first of these two parts of a series [*cf. R.A.E.*, A **39** 64], the author records the results of studies on the life-cycle of the shot-hole borer of tea [*Xyleborus fornicatus* Eichh.] carried out by means of a laboratory rearing technique in Ceylon, some of which have already been noticed [*cf.* **37** 136], and compares them with those deduced from investigations of galleries of known ages [**30** 232]. In addition to work at a controlled temperature of 82°F. [**37** 137], observations were made at an altitude of 3,500 ft. (mean room temperature 73°F.), where the egg and pupal stages lasted 7–8 and 8 days, respectively, and at 4,500 ft. (mean room temperature 68°F.) where the larval and pupal stages lasted 18–33 and 10 days. It is estimated that the preoviposition, egg, larval and pupal stages last 10, 7, 15 and 8 days, respectively, at 3,000–3,500 ft., and the adults remain in the galleries for five days after emergence. Pairing probably occurs during this time, and the frequent finding of small broods that do not include a male suggests that many females are not fertilised and consequently do not reproduce. This would explain the existence of numerous galleries that do not contain eggs or young.

In the second, the author reviews methods that have been adopted for estimating populations of the borer in tea plantations [*cf.* **32** 305] and states that although the number of broken branches affords a measure of the damage done, this depends on the number of galleries rather than the number of insects in the bush and is affected by the treatment received by the bush, so that it may not be proportional to population. Weekly records made during the three-year pruning cycle of 1940–43 in an area in the Passara district showed that freshly broken branches were few at the beginning of the cycle but increased towards the end of the first year and reached a peak at the end of the second. The numbers decreased early in the third year and finally became relatively stable at a low level. Records made in 1940–41 by pruning sample bushes and counting galleries and beetles in the prunings in the same area during work already noticed [**31** 396] showed that the population increased from 14 per bush in the 19th month after pruning to 87 in the 23rd month and was 7 or less at the end of the third year, and numbers of galleries per bush increased from 3 to 25 between the 19th and 23rd months and to about 100 at the end of the third year, when, however, occupied galleries were rarely found. Counts of galleries in broken branches in 1943–46 failed to show a similar fluctuation, although it undoubtedly occurred, and attempts were made to obtain the information from the records in other ways.

The average numbers of insects in occupied galleries proved of little value as indicators of the fluctuations in population, but the percentage of galleries occupied showed more promise. It is shown that this varies with the reproductive rate (number of reproducing females produced by each reproducing female in successive generations) and that it becomes 50 when the rate is two and 75 when it is four and approaches zero when it is one or less. During the 1943–46 cycles, the percentage was 60–70 until 22nd November 1944, indicating a reproductive rate of about three, and 40–50 from then until 1st August 1945 (reproductive rate 1·6–2), but it fell rapidly to five by 19th December 1945, showing that the rate was less than one and the population dying out. These conclusions were supported by the numbers of broken branches collected each week, and it was clear that after the first generation, the reproductive rate decreased steadily throughout the cycle, until the population was almost extinct by the beginning of the third year.

Healing of the galleries [*cf.* **38** 85] has been shown to take place in the course of 2–3 generations (3–5 months), and it is calculated that at reproductive

rates of two and three, the percentages of healed galleries eventually become stable at 12·5 and 3·7, respectively. Increasing percentages of healed galleries indicate a decreasing rate of reproduction until the reproductive rate becomes one, when the percentage will increase slowly although the population remains constant. A diminishing population can be detected only by a more rapid increase in the percentage of healed galleries. In the 1943–46 cycle, the percentage remained low until the end of November 1944, was about 30 from March to the beginning of October 1945 and then rose rapidly to about 80, showing a decreasing reproductive rate that probably fell below one in July or August.

It is concluded that the increase of damage in the second year of a pruning-cycle and its decrease in the third are due entirely to the growth and decline of the beetle population.

Nijveldt (W.). **Galmuggen van cultuurgewassen. I. Galmuggen van fruitgewassen.** [Gall Midges on cultivated Plants. I. Gall-midges on Fruit Crops.]—*Tijdschr. PlZiekt.* **58** pt. 3 pp. 61–80, 28 figs., 18 refs. Wageningen, 1952. (With a Summary in English.)

This is the first part of a series on the Cecidomyiids of importance as pests of economic plants in Holland and deals with those that attack fruit trees and bushes. It is pointed out in the introduction that a knowledge of the bionomics is required for control. The dates of adult flight can be ascertained by placing plant material bearing galls containing full-grown larvae on the ground and covering it with specially-designed cages [*cf.* *R.A.E.*, A **26** 466], which trap the adults as they emerge. In cases in which the larvae or pupae over-winter, the cages should not be set out until just before the adults are expected to emerge. Some galls give rise partly or wholly to inquilines or predators, but the harmful genera can readily be recognised by their morphological characteristics. The species are most easily identified by reference to the food-plant and the type of gall, and it is therefore important that the emergence cages should be placed where there is no possibility of other species being present in the soil. Techniques for rearing adults from galls and for preparing specimens for identification are described.

The most important species dealt with in this part and their usual food-plants are *Contarinia pyrivora* (Ril.) on young fruits of pear, *Dasyneura mali* (Kieff.), *D. pyri* (Bch.), *D. tetensi* (Rübs.) and *D. tortrix* (F. Lw.) on leaves of apple, pear, black currant and plum, respectively, and *Ischnonyx prunorum* (Wachtl) on damson buds. *Thomasiniana oculiperda* (Rübs.) occurs mainly in rose nurseries, but has occasionally been found on grafted pome and stone fruit trees. *T. theobaldi* Barnes is also included, as it occurs in neighbouring countries on raspberry canes, though it has not yet been definitely recorded in Holland. Descriptions are given of each of the genera and of the symptoms caused by the different species, together with notes on their bionomics, distribution and alternative food-plants based largely on the literature.

Kuenen (D. J.) & Lems (H. G.). **De invloed van het voedsel op de eiproductie van de perebloesemkever,** *Anthonomus cinctus* **Koll.** [The Influence of Food on the Egg Production of *A. piri*.]—*Tijdschr. PlZiekt.* **58** pt. 3 pp. 80–84, 3 graphs, 1 ref. Wageningen, 1952. (With a Summary in English.)

During observations on *Anthonomus piri* Koll. (*cinctus* Redt.) on pear in Holland [*R.A.E.*, A **39** 127], it was observed that infestation was considerably heavier on some varieties than on others. In an investigation of the cause of this, three groups of field-collected females were placed in petri dishes at suitable temperature and humidity and allowed to feed and oviposit for ten days on fresh excised fruit buds of a variety of pear that suffered heavy infestation.

The numbers of feeding punctures and of eggs laid per female were approximately equal in the three groups. Two of the groups were then allowed only buds of less heavily infested varieties, and it was found after a week that food consumption was almost unchanged but that the oviposition rate had fallen by 50 per cent. or more. When the original feeding conditions were restored, egg production rose again.

WIESMANN (R.), GASSER (R.) & GROB (H.). **Über ein neuartiges, selektives Aphizid mit Tiefenwirkung.** [On a new selective Aphicide with systemic Action.]—*Experientia* **7** no. 3 pp. 117–120, 18 refs. Basle, 1951. (With a Summary in English.)

The material dealt with in this paper is the urethane, 5,5-dimethyldihydroresorcinol-dimethylcarbamate, and it is referred to under the number 19258. It was synthesised in Switzerland, has a melting point of 45–46°C. [113–114·8°F.] when recrystallised from cyclohexane and is soluble in water at 20°C. [68°F.] to the extent of 3·15 per cent. and in most organic solvents. It is much less toxic *per os* to laboratory animals than parathion or nicotine, and, unlike parathion, is but little absorbed through the skin. Tests showed it to have both stomach and contact action against many insects at high concentrations and against Aphids at low ones. In tests with *Aphis rumicis* L., the median lethal dosage on ingestion was about 0·8 mg. per kg. insect body-weight, the same as for parathion, and mortality ensued in a few hours when the Aphids were exposed to deposits of 0·001 mg. per 100 sq. cm. It is translocated in the sap stream of plants and seems particularly suited for use against Aphids. The symptoms caused, which are described, include knockdown, paralysis of the extremities and tremors, and working of the mouthparts and oesophagus, so that the insects swallow air and become swollen. The acidity of the blood and muscles is increased.

A preparation containing 10 per cent. 19258 was developed, and tested in sprays against Aphids in the field in Switzerland in 1949 and 1950. A spray containing 0·01–0·02 per cent. active ingredient gave complete mortality of fundatrices of *Aphis pomi* Deg., *Anuraphis* (*Dentatus*) *crataegi* (Kalt.) and *A. roseus* Bak. (*D. malicola* Mordv.) by contact when applied to apple trees in late March, before flowering, and the trees were free from infestation during an observation period of two months. The material also gave good or very good mortality in summer of numerous other Aphids on fruit trees and bushes at concentrations of 0·02–0·03 per cent. 19258, including species that live in rolled leaves, which were controlled systemically, and gave complete mortality of the woolly apple aphis, *Eriosoma* (*Schizoneura*) *lanigerum* (Hsm.), at 0·04 per cent. At 0·02–0·04 per cent., it gave complete mortality of *Aphis* (*Doralis*) *fabae* Scop. on beet, but was not outstanding against other Aphids on vegetables. It thus possesses considerable selectivity, even among Aphids. When an apple tree was sprayed at 0·04 per cent. in midsummer and counts were made of all the insects and other arthropods that fell from it in 46 hours, there was little or no mortality of any species except Aphids, though some adult Diptera of no importance were killed.

PAPERS NOTICED BY TITLE ONLY.

DIRSH (V. M.). **A practical Table for the Determination of Sexes of Nymphs of** *Locusta migratoria migratorioides* **(R. & F.) (Orthoptera : Acrididae).**—*Proc. R. ent. Soc. Lond.* (B) **19** pt. 9–10 pp. 136–138, 2 figs. London, 1950.

VAPPULA (N. A.). **Finnish Entomological Literature published in 1950 including** [titles of papers on] **Economic Entomology and Control of Insect Pests.**—*Ann. ent. fenn.* **18** no. 1a 17 pp. Helsinki, 1952. [*Cf. R.A.E.*, A **40** 128.]